Britain's new industrial space? A case study of high technology Hertfordshire'

Thesis

Britain's New Industrial Space? A Case Study of "High Technology Hertfordshire"

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Abstract

The suggestion is now widespread that fundamental changes within the advanced Western economies are part of the transition to a new era of capitalist development. The geographical repercussions of this change, the form of the new geography of production, has become the subject of much conjecture. The question has become one of explaining how the present period of economic restructuring is being translated into a period of spatial restructuring.
A key element of such theories of change has been the "high technologies", defined both as a process of change and as the basis of new industries encapsulating new forms of production. Indeed, for the proponents of the New Industrial Spaces theory, the rise of "high technology" industry is the harbinger of structural change and its spatial development indicative of the new geography of production we may expect throughout North America and Western Europe (Scott and Storper,1986; Scott,1988a; 1988b).
This thesis outlines a theoretical and empirical investigation of the New Industrial Spaces theory, an investigation framed by the principal claim of the theory to explain the processes structuring the emergent geography of production. Firstly, a critique of this claim argues that whilst the explanation provided (based on transaction costs) is plausible, it rests upon a particular and deficient conceptualisation of the firm. Secondly, allowing for such reservations, it is argued that the explanation of the New Industrial Spaces' theorists has yet to be shown as empirically valid. Thus, in the search for this evidence, an empirical investigation of Britain's own prominent candidate for the title New Industrial Space, namely "high technology Hertfordshire", is undertaken. Whilst this empirical investigation provides evidence for the New Industrial Spaces theory, it also highlights the theory's failure to explain fully the growth of "high technology Hertfordshire". In contrast, the thesis develops an alternative conceptualisation of contemporary agglomerations of production.

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Nick Henry
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CHAPTER ONE: Welcome Aboard The (Earth-bound) U.S.S. Enterprise

1.1 Introduction

This thesis represents the fusion of, for me, two compelling elements of society today, elements encapsulated in the cult programme, Star Trek. On the one hand is that aura of science, technology and (economic) progress, as Scotty ("the technological wizard") desperately strives for Warp Factor mind-boggling with a mechanised toothpick, and Spock scans yet another surprisingly "Earth-like" planet suitable for human life-forms. On the other hand, is the mission of the U.S.S. Enterprise itself, "to go where no (hu)man has gone before", to investigate "**space: the final frontier**".

Today, back on Earth, scientific progress and wizardry has become synonymous with "high technology" or rather "high-tech". The "ideology of high-tech" (Morgan and Sayer,1988) implies the term's use as a prefix to all and sundry goods, whether training shoes, furniture, architecture or, most chillingly, a "war of the 90s" in the Gulf. Most insistently, however, "high technology" has also become the policy-makers' panacea for economic decline, the "technical fix", the "sunrise" of a new golden era of growth.

Also back on Earth, and with an admitted play on words, "space" becomes "the distance, expanse or area between or within things". Thus, the mission may be re-interpreted as

one of investigating exactly what are the ("spatial") relations which structure the distance between things. In other words, what relations structure the geographical organisation of things and, for this particular thesis, what are the relations which structure the geographical organisation of, not things, but industry.

Whilst this investigation of the "spatial", in the abstract, may be a difficult concept to grasp, its purchase on today's world may soon be shown. For example, the destruction of the Amazonian rainforests, massively expanded in the last 15 years or so by the lighting of 8,000 fires a day during the "burning season" (Kaufman et al.,1989, quoted in Hecht and Cockburn,1989), has brought to the attention of the world the "Greenhouse Effect". In turn, while Britain sweltered through record temperatures in the summer of 1990, many saw it as a partial result of the burning of the Amazonian. Yet, to link the two instances, requires the specification of a spatial relation of which we know very little. Exactly what the regional (spatial) impacts of the Greenhouse Effect are, and will be, is a matter of intense and heated (!) debate (Warwick and Farmer,1990).

A further example of the importance of the "spatial" is the popular concept of Britain's economic and social "North-South divide" (Champion and Townsend,1991). Indeed, the concept's political significance burst forth recently as the "one-nation" Tories, led by Michael Heseltine, mounted a challenge for the leadership of the Conservative party, only to be outdone by a man with a "vision of no division",

North-South or otherwise, within Britain (see also Martin,1988a). Yet, before such a vision can be realised, the relations structuring this "geographical divide" or, for that matter, any form of geographical organisation must be uncovered. A mission to investigate the "spatial" in society is, indeed, of relevance.

Moreover, the North-South divide is also an example of particular pertinence to the substance of this thesis. For it represents, in part and rather crudely, the geography of economic growth and decline in Britain today. It is part of the uneven spatial development of Britain's industry. And it is this uneven spatial development, and particularly that part attributable to "high technology", which this thesis will focus upon. It is the fusion, in several different ways, of "high technology" and uneven spatial development in Britain today which is the driving interest behind this piece of research.

"High technology" and the anatomy of job creation

The geography of economic decline and its explanation, partly conceptualised in the phrase the "anatomy of job loss", has been extensively studied in the last decade or so (see, for example, Massey and Meegan,1982; Martin and Rowthorn,1986). However, a renewal of our concern with the "anatomy of job creation" has been called for once more (Boddy,1987; Hall,1987). For, whilst Britain has experienced the dramatic decline of its metropolitan cities and historically important industrial regions such as the valleys of South Wales, the West Midlands and the North

East, the emergence of new regions of economic growth has also been mapped with much ensuing hyperbole, none more so than the "high technology" regions of the M4 Corridor and Silicon Glen.

Public announcements of innumerable heritage centres and theme parks highlight that the leisure and tourist industries form another part of this new wave of economic growth but it is the set of industries known as "high technology", beyond all others, which has captured the imagination. Wrapped up in images of white coats and green fields, quiet, clean, and traversing the world at the push of a button, these industries and their technologies have come to represent the industries of the future and, as such, the industries which will give "a place" (both in the spatial and aspatial sense of the term) in that future. Thus, it has been these industries which have topped the shopping list of policy-makers at the national and local level. "High technology" has become the prime target of regional and local development programmes, a cure for Britain's uneven spatial development.

<u>"High technology" as cure or symptom?</u>

It is in this policy realm, as much as any other, that a particular "ideology of high-tech" has taken hold. For, firstly, there is no simple correlation between the appearance of new technologies, and their associated industries, and job growth. Indeed, Chapter Two opens with a quote by Hall et al. (1987) identifying recent job loss within the "high technology" industries. Moreover, the

chapter goes on to discuss differing views of the impact of "high technology", including those which see large-scale technological unemployment as a consequence.

Furthermore, the fact of "high technology" job loss nationally has seemingly been lost in the "silicon images" of those few parts of Britain which have profited from the growth of "high technology"; images which precisely highlight the uneven spatial development of Britain's "high technology" industry itself. Moreover, and rather depressingly, Chapter Three shows how this uneven spatial development mirrors, or rather contributes to, that uneven spatial development depicted in the North-South divide. In other words, "high technology", whilst being suggested as the cure, is actually part of the symptom.

Finally, if the full meaning of uneven spatial development is understood, the belief:

> "...that other places can hope to clone Silicon Valley's [or even the M4 Corridor's] development is deeply misconceived. This is because it is an integral part of a larger structure of combined and uneven development - the inter[national] spatial division of labour in electronics - and not an island of growth, divorced from developments elsewhere. Within this structure, different places have different yet interdependent roles, so that changes in one part imply changes in another. Since there is only a limited amount of prestige functions within the industry to go round, the dreams of the hundreds of local boosterists wanting to emulate Silicon Valley could only be realized simultaneously by a miracle equivalent to that

> depicted in the parable of the feeding of the thousands with two fishes and five loaves." (Morgan and Sayer,1988,p.39)

Yet, although such a blinkered scenario of a "high technology" future may be criticised, especially for its condemning to the "dust(rust?)bin" a vast range of declining industries, regardless of their possibilities for rejuvenation and, indeed, their actual "high technology" content (see Chapter Two), this image does hold an element of truth. The misrepresentation of "high technology as job generator" may partially explain its unwarranted popularity, but it is hard to see how this factor fully explains the symbolic importance of "high technology" both within, and beyond, the field of economic development. Yet what the popular symbolism of "high technology" most represents, more than anything else, is summed up in terminology such as that of "leading-edge", "advanced", "progress" and, ultimately, "the future". And it is this image, if any, of "high technology" **as part of the** (but not the whole) **future** which does hold true. "High technology" may not be synonymous with job creation, but it may be argued that it is a symptom of structural change in the economy (and society).

"High technology" and structural change

Although a switch in the focus of study from the anatomy of job loss to that of job creation may be taking place, it must be realised that the theory of such economic change intricately includes and links the two substantive areas. They are but two sides of the same coin of "restructuring".

Study of the "anatomy of job loss" suggests its cause to be rooted within a crisis of capitalism in the advanced Western economies (Bluestone and Harrison,1982; Massey and Meegan,1982; Martin and Rowthorn,1986). Similarly, however, the "anatomy of job creation" is also rooted in the dynamics of capitalist accumulation, and the response to such crisis in particular. The major transformations recently witnessed within the British economy (including its economic geography), highlighted in the dichotomous analogy of Hall (1987), are more than mere incremental change by the capitalist system. Rather, what we are witnessing is structural change within the system (Freeman,1986; Harvey,1987; Lash and Urry,1987; Leborgne and Lipietz;1988; Lipietz,1986; Piore and Sabel,1984; Scott,1988b).

And it is from theories of structural change that "high technology" truly gains its symbolic significance (and interest). For, just as popular conceptions view it as the future so, within theories of structural change, "high technology" is viewed as the harbinger of structural change, more so as part of the process of restructuring. In fact, it is argued that the appearance of "high technology" industry (major job creator or not) is nothing less than indicative of a new phase in the historical development of capitalism (Hall,1981; Leborgne and Lipietz,1988; Marshall,1987; Piore and Sabel,1984; Scott and Storper,1986; Scott,1988a; 1988b).

"High technology" and the new geography of production

Just as distinct forms of uneven spatial development have characterised previous economic periods, so the uneven spatial development of "high technology" is being argued to be symptomatic of the space economy of an emergent economic era. In other words, the uneven spatial development of "high technology" is being seen as the future spatial form of the geography of production (Scott and Storper,1986; Scott,1988a; 1988b). For Scott and Storper, in particular, that spatial form is (re)agglomeration of production, and the growth of "high technology" industrial agglomerations is just one element of a new geography of production, otherwise known as the New Industrial Spaces.

Thus, an interest in "high technology" and its uneven development eventually leads us to the claim of the New Industrial Spaces' proponents that agglomeration (of "high technology" industry) is exemplary of the new geography of production. And it is this claim which this research will investigate. Moreover, this investigation will take a particular line of enquiry. For, as stated earlier, the research mission's general objective is to investigate the "spatial"; to gain greater understanding of the relations which structure the geographical organisation of industry. Thus, if, as Scott and Storper argue, (high technology) agglomeration represents the emergent production geography of Western capitalist industrial development, the question to ask is what are the relations structuring the formation of this pattern. That is, **what are the processes driving the contemporary growth of agglomeration?**

Hence, through a theoretical and empirical analysis of the **processes** structuring the **pattern** of uneven development of Britain's "high technology" industry, this research will investigate the causal process(es) argued to be structuring a central element of the economic geography (the New Industrial Spaces) of a new historical period of capitalist development.

1.2 The Structure of the Mission

The starting point of the mission, then, is to outline the pattern of "high technology" industrial development in Britain. However, an immediate problem arises concerning what is actually meant by "high technology". As Chapter Two reveals, whilst "high technology" may not represent a concept "far too incoherent to be of any analytical use" (Morgan and Sayer,1988,p.37), it is a moving target. The boundaries of any listing of "high technology" industry continually oscillate, dependent on which particular combination of a myriad of indicators is taken to create a listing.

This problem of definition is revealed in Chapter Two through a comparison of various recent estimates of "high technology" employment in Britain. Some of the reasons for this diversity of estimates (based on the indicators used) are then discussed. However, the chapter then goes on to argue that the diversity of indicators used, and therefore definitions of "high technology" taken, are a consequence of **theory-laden** views as to what "high technology" is; theory-laden views which shape any choice of industrial

sectors as "high technology". By explicitly recognising the theory-laden element of definition, and in contrast to the argument of Morgan and Sayer (1988), it is argued within Chapter Two that coherence may be brought to the concept of "high technology". This coherence may be derived by "stepping back" to theories of structural change within which "high technology" is conceptualised as a particular element of a process of (structural) change. For, in essence, it is the characteristics which arise from the structural role given to "high technology" within such theory which set the definitional parameters for the concept and any ensuing indicators of high technology.

Finally, at the end of Chapter Two, the implications which arise from the (re)conceptualisation of "high technology" in terms of a process of change are dealt with by a return to the issue of "high technology" and its impact on employment. Most especially, it becomes clear that those impacts, firstly, are uneven and secondly, may be critically determined by forces outside the sphere of the technology itself but part of the wider process of change.

Once a clearer view of "high technology" has been achieved in Chapter Two, the mission is able to continue with the process of outlining the industrial geography of Britain's "high technology" industry. Confirming one of the conclusions of Chapter Two, the geography of "high technology" described in Chapter Three clearly describes an uneven impact. It is a description of a high technology spatial divison of labour dominated, numerically and functionally, by the Western Crescent, a select few

counties of the South East of England. In other words, it is a picture dominated by a "high technology industrial agglomeration".

With the aim of the mission being that of identifying and explaining the processes structuring such a geographical pattern, Chapter Three turns, in its latter half, to theories of uneven spatial development. In the previous chapter it has already been seen that "high technology" may only be understood as an element of a process of change conceptualised within such theory and, hence, it is to such theory we must turn to identify exactly what processes of change "high technology" represents. Three theoretical viewpoints - long waves, industrial divides and regimes of accumulation - are discussed, each with their own conceptualisation of "high technology" as representative of a process of change. Thus, in turn, and arising from these differing conceptualisations, each theory's particular interpretation of the geography of "high technology" is outlined; interpretations which identify different causal processes structuring the pattern of "high technology". That is, different explanations as to how processes of change, encapsulated in the term "high technology", are working to structure an emergent pattern of industrial development.

Particularly forthright in its explanation is the New Industrial Spaces thesis of Scott and Storper (1986; Scott,1988a; 1988b) which, as much as any other work, has made prominent the symbolic importance of "high technology" and its uneven spatial development. Within the work of

Scott and Storper, a detailed rationale (a precise logic of "transaction costs") is advanced in explanation of this new geography of agglomeration. In effect, Scott and Storper provide an explanation of exactly how the processes, as well as what processes, of change are **translated** into an emergent geographical pattern. It is upon this explanation that the mission will focus.

Thus, Chapter Four develops a theoretical discussion of the New Industrial Spaces thesis. Firstly, the theory is outlined in greater detail and, in particular, the "logic of translation" set out. A path of structural economic change engendering change in production logic and, thus, change in economic behaviour by firms which, by virtue of the "transaction costs" mechanism, precipitates a change in locational behaviour is traced. The outcome of that locational behaviour is argued to be agglomeration and the name given to these new agglomerations of production is the New Industrial Spaces.

Once outlined, the New Industrial Spaces thesis is then subjected to a theoretical critique. The critique begins with a discussion of the arguments for and against the particular path of structural change adopted in the New Industrial Spaces approach; namely, the transition to a post-Fordist regime of flexible accumulation. It then follows with an alternative view (encompassing more possibilities) of the likely economic behaviour of firms in response to this structural transition. Following this, and in line with the particular focus of the research, a more

insistent critique of the locational mechanism of "transaction costs" is then described. Most especially, this part of the critique takes a realist view of social phenomena to **de-construct** the ways in which the mechanism is alleged to operate to produce agglomeration. In particular, this deconstruction brings forward the role and meaning of contingency in explaining social phenomena. Finally, in the light of this analysis of the causal mechanism of the New Industrial Spaces, Chapter Four ends with a critical discussion of the empirical evidence for the mechanism's operation in forming the New Industrial Spaces. It is concluded that whilst empirical evidence of a variety of agglomerations has clearly been provided within the New Industrial Spaces theory, the same can not be said concerning the evidence for the **causal mechanism(s)** driving the growth of such agglomerations.

Thus Chapter Four, with certain qualifications attached, concludes that the New Industrial Spaces theory does provide a theoretically plausible (but not necessary) explanation for the contemporary agglomeration of production. However, in the light of the empirical evidence provided, the question remains as to whether or not this hypothesis is also empirically relevant. It is the search for such empirical evidence which sets the framework for the remainder of the mission.

In Chapter Three, Britain's premier "high technology industrial agglomeration", the Western Crescent, was identified. In Chapter Five, a preliminary reading of the distinguishing characteristics of a New Industrial Space

confirm the Western Crescent's, and in particular one of the leading counties within it, "high technology Hertfordshire's", compatibility as a prime candidate for the title New Industrial Space. The remainder of Chapter Five outlines the two-stage methodology subsequently employed to investigate this candidature.

Firstly, much more information and evidence is required to confirm that "high technology Hertfordshire" does, indeed, represent a fair and valid candidate with which to investigate the New Industrial Spaces thesis. The gathering of this evidence involved the collation of results of other explorations of the region backed up by a long range scan, by postal questionnaire, of high technology establishments in Hertfordshire. Exactly how this questionnaire was undertaken and its success is explained in the chapter. The results of this stage of the exploration are detailed in Chapter Six.

Chapter Six analyses the rapid industrial growth of "high technology Hertfordshire" such that, today, it is arguably the leading "high technology" location in Britain. The bedrock of this growth has been the aerospace and other defence industries, overlain by the growth of computer electronics and pharmaceuticals and, most recently, the rapid growth of a computer services sector. The county's growth, combined with other agglomeration characteristics such as specialised "high technology" labour markets and a general environment of "high technology", clearly matches it with those descriptions of New Industrial Spaces which have been put forward.

However, within the theoretical critique of Chapter Four, it is argued that whilst the requirements for evidence of agglomeration have been met satisfactorily within the New Industrial Spaces thesis it is, critically, evidence of the **causes** of such agglomeration which is lacking (ie.evidence for the transaction costs mechanism). Similarly, such evidence is lacking from the description of "high technology Hertfordshire" given in Chapter Six. Hence, it is the search for such evidence which the second stage of the exploration methodology addresses. As Chapter Five describes, the postal questionnaire also serves a second role, that of identifying establishments in Hertfordshire whose locational decision suggested the operation of the "transaction costs" mechanism. And, once identified, a series of case studies, by interview, of these establishments was undertaken to discover exactly **how** the locational mechanism had operated to cause agglomeration. Thus, a long range scan of "high technology Hertfordshire" was followed up by a "landing" in the region.

Chapter Seven, then, outlines the second (and major) form of analysis of the postal questionnaire results. Through this analysis the agglomeration of "high technology Hertfordshire" is dissected to discover exactly how many establishments fitted the locational model of the New Industrial Spaces thesis. Moreover, the manner of this "fit" is then investigated through a series of case studies. Thus, the chapter provides a detailed empirical study of the causal mechanism of the New Industrial Spaces and completes the theoretical and empirical investigation of the New Industrial Spaces thesis.

However, from Chapter Seven, it becomes clear that only a minority of those high technology establishments surveyed fit the locational model of the New Industrial Spaces. In other words, the model fails to fully explain "high technology Hertfordshire". Therefore, in Chapter Eight, further possible explanations of "high technology Hertfordshire" highlighted by the postal questionnaire returns are identified and, once more, investigated through a set of case study interviews.

Finally, back on board, Chapter Nine describes the iterative fusion of newly gathered fieldwork with past theoretical conceptions. Firstly, this fusion extends our knowledge of that part of space known as "high technology Hertfordshire". Secondly, further insight into theories of (Earthbound) economic space, particularly that of the New Industrial Spaces thesis, is gained. Thirdly, such insight ultimately leads to an alternative conceptualisation of those (spatial) relations structuring a contemporary industrial agglomeration.

Bon Voyage!

CHAPTER TWO : How High Are You? High Technology and Questions of Definition

2.1 "High Technology" as Job Generator?

> "...at the national level the much vaunted 'high technology' group upon which so much hope seems to be pinned, contributes not to employment gain, but to substantial loss. In fact, over 15% of these high technology jobs were lost over the period [1971-83]." (Hall et al.,1987,p.18)

So conclude the authors of one of the most recent influential books on "high technology" industry in the United Kingdom.

Hall et al. (1987) described a fall in "high technology" employment from 689,100 in 1971 to 583,700 in 1983. Using the updated 1980 SIC base they found the reduction in "high technology" employment from 1981-1984 to be 13,200 jobs or 1.5%. Butchart (1987), also using the 1980 SIC, has similarly described the decline of "high technology" employment. In 1975 employment stood at 1,358,000 and reached a low of 1,234,000 in 1983. In 1984 employment rose to 1,249,000 only to once more continue its decline to 1,239,000 in 1986, 6% of total UK employment.[1] Employment decline would seem to characterise the "high technology" industries of the United Kingdom.[2]

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[1] Most recently, Champion and Townsend (1990), using Butchart's (1987) definition, have charted a 5.5% decline (representing 66,900 jobs) in UK "high technology" employment between the years 1981-1987.

[2] Yet, as Keeble (1989,p.155) has noted, "high technology" employment decline was still less than a third of that for manufacturing as a whole during the period

Although these commentators all agree that there has been a decline in employment, an interesting point to note is Hall et al.'s (1987) figure for "high technology" employment, in 1984, of 879,800, as compared to Butchart's (1987) figure of 1,249,000 for the same year. In further comparison, Cooke (1986) gave an approximate figure of 650,000 "high technology" jobs in 1986 compared to the figure Butchart (1987) gives of 1,239,000. Thus, whilst one may continue to hold the initial view that "high technology" employment has declined, from the above figures it is difficult to tell by how much and from what level.

The extent of confusion about the precise aggregate numbers of UK "high technology" jobs is only heightened by the move to a disaggregated list of jobs per "high technology" industrial sector. For example, one industrial sector generally agreed upon as "high technology" is "information technology (IT)". In a recent study, total employment in IT in December 1984 was given as 1,714,000 (Preston et al., 1985,Appendix 2). In other words, the sector had nearly 500,000 more jobs than the **whole** of "high technology" industry put together if comparison is made with Butchart's (1987) figure, let alone the figure of Hall et al. (1987)! Clearly something is amiss but, on closer inspection, a logical explanation for the widely variant estimates of "high technology" employment can be put forward. This explanation may be derived from the major problems encountered in the **definition** of "high technology"

1975 to 1986. Furthermore, Butchart (1987,p.87) shows that over a similar period the ouput of the "high technology" industries averaged a growth rate of 2.8% per annum. In other words, "high technology" industry has undergone a period of **job-loss growth.**

industries, revolving around both conceptual and operational issues and their interplay.

2.2 Pick-a-(Dualist) Definition

Hall et al. (1987), when finalising their definition of "high technology" industry, initially concentrated on the conceptual difficulties of definition involving three separate dualisms: high technology producers/high technology users, high technology/new technology and, implicitly, manufacturing/services.[3]

Producers and users

The question of whether or not to include producers and/or users of "high technology" in any definition is relevant due to the distinction to be made between "high technology" **products** as against "high technology" **production processes** (ie.the use of "high technology" products in production).

This distinction produces a four-part matrix by which industries can be classified, ranging from industries producing "high technology" products using "high technology" production processes such as aerospace to those industries using low technology production processes to produce low technology products such as widgets (Hall et al.,1987,p.11). In between, one classification alternative represents the use of low technology production processes

[3] See Sayer (1989a) for a discussion of the dangers of dualistic thinking in geography, and the social sciences more generally.

to produce "high technology" products, for example, the labour intensive assembly of semiconductor chips (Henderson and Scott,1988). The final classification involves industries such as the motor industry, using high technology "robotic" production processes to make low technology products, or the use of computer cutters in the clothes industry (Hardill,1988).

Further work which highlights the technological sophistication of "user" industries is that by Townsend et al. (1981,p.91, see also von Hippel,1988). Their work has shown that industrial sectors traditionally regarded as "low technology", such as textiles and footwear, were major net importers of technology between 1945-1980 (quoted in Charles and Howells,1987). Furthermore, Charles and Howells (1987) have themselves suggested that nearly one third (31.9%) of all UK R&D expenditure for 1985 was accounted for by "traditional" industries (excludes services), including 38.2% of privately funded R&D expenditure. One particular example they highlight is the widespread application of biotechnology within the "traditional" food and drink sectors.[4]

Today, one technology, microelectronics, is sweeping through industry and at the same time emphasising the debate over the producer/user duality. As early as 1980 the CSE Microelectronics Group documented the impact of microelectronics on production processes ranging from the

[4] An interesting example of biotechnology within the food industry is the recent (February 1991) announcement made by Delta Biotechnology, a subsidiary of a major brewer (Bass). Within their laboratories they have carried out the first stages in the creation of "yeast-derived" human blood.

coal industry to motor manufacture, banking and education (CSE,1980). One study of the UK found that, by 1983, 18% of all production processes contained microelectronics (Northcott and Rogers,1984, quoted in Hall et al.,1987). A recent update of this study has gone on to suggest that:

> "...59 per cent of factories, representing five-sixths of total manufacturing employment, now use the chip to automate production to some extent..." (Large,1988)

Thus, the widespread diffusion of microelectronics is just one possible example of the impact the inclusion of "high technology" users would have on the definition of "high technology" industry. In effect:

> "... a definition based on aggregate industries which included high tech process users would incorporate many industries making traditional products." (Hall et al.,1987,p.11-12)

Yet it is questionable whether such a dualism is ultimately helpful in developing a definition. For the problem with the model of classification used above is that:

> "In reality, of course, these quadrants may merge, with a combination of low and high technology products being used in any production process for making any 'high' or 'low tech' product." (Hall et al.,1987,p.11)

Hence, whilst assembly of semiconductors represents an unskilled low technology process, the (continued) innovation of the semiconductor itself is widely viewed as

the core of the information technology revolution. Furthermore, Hall et al. (1987) have gone on to highlight the difficulty of making a distinction between producers and users anyway, for example, in the case of computer software consultants. But they conclude by stating their particular interest to be with that of "high technology" **producers** alone.

High technology and new technology

On reaching a decision about the producer/user duality, Hall et al. (1987) are immediately confronted with the problem of a second duality within definition, that is "high technology" as against "new technology". Several previous studies have avoided the term "high technology" preferring the term "new technology" (see for instance Brady and Liff,1983). The classifying of technology temporally, as an option to making value judgements as to what is or isn't "high technology", on first glance seems preferable. However, Hall et al. (1987) go on to outline the problem of "dating" a technology, which simply replaces the previous problem of making qualitative decisions on technological content.

For example, and outlining geography as an important element, they suggest that the date of introduction of a "new" technology varies across industries, regions and nations. Equally, the ability to classify industrial processes according to the period in which the technology was developed may be hampered when technologies emerge over a period of time which coincide with more than one phase of

industrial innovation (op.cit.,p.12-13). One need only look at "long wave" theory, and the debates presently taking place within it, to exemplify the importance and yet extreme difficulty of "dating" innovation and technological progress.

Mensch (1979) in his epic work *Technological Stalemate: Innovations Overcome the Depression* argued that he had identified particular years, "radical years of history", in which heightened innovation - the driving force behind long waves - took place, only for his work to be discredited by Freeman et al. (1982) partly on the basis of his dating of innovation:

> "...there is a high degree of ambiguity surrounding any estimate of invention and innovation dates, and differences of opinion are likely even when a single source of information such as Jewkes et al. is used. Some of those classified to the 1930s in Mensch's list could equally plausibly be allocated to other decades..." (Freeman et al.,1982,p.47)

Instead, Freeman et al. (1982) argue for the importance of diffusion and adoption of technology rather than its actual innovation date.

Manufacturing and services

The third duality, that of the distinction between manufacturing and services, does not represent an initial problem to Hall et al.(1987) because of their earlier decision to concentrate on **producers** of high technology.

They recognise that the service industries also undertake a **production process** which may result in a high technology product, for example, computer software. While this may seem obvious today, such a recognition is an advance on previous theory. Take, for example, economic base theory which views services as dependent upon the independent and wealth-creating manufacturing sector.

However, if, in conclusion, the above dualisms highlight the need for "conceptual" thought before attempts to define "high technology" industry are made, the pragmatic requirements of gaining an operationally adequate definition often ultimately override such thinking. For example, Hall et al.(1987) arrive at a final definition of "high technology" industry which includes no service sectors despite their initial conceptual decision to include services. This is due not to the fact that no service industries were found to be "high technology" but rather, that none of the information required to produce the proxy indicators of "high technology" on which Hall et al. based their definition was actually available for services (op.cit.,p.16). Hence, services are conceptually included but operationally excluded.

This outcome is all the more unnerving given Hall et al's (1987) express aim to be "objective" in their definition of "high technology" industry, in comparison to earlier "subjective" approaches (op.cit.,p.13).

The "objective" and the "subjective" approaches to definition

Breheny et al. (1985) discuss how the "subjective" approach to definition, seen in the work of Oakey (1981), Haug (1986) and Cooke (1986) amongst others, involves value judgements as to which industries (by SIC) should be classified as "high technology". This approach:

> "... avoids thorny conceptual problems and gives a working definition, [but] it is very unsatisfactory in that it is peculiar to the analysts concerned, has no objective base and makes comparison virtually impossible." (Breheny et al.,1985,p.120)

In contrast, the "objective" approach involves attempts to identify characteristics *a priori*, and hence proxy indicators, of "high technology" (industries), and a large amount of research has been undertaken aimed at identifying such indicators (for example, see Glasmeier et al.1983; Hall and Markusen,1982; Langridge,1984; Premus,1982).

Inputs and outputs

Monck et al. (1988) usefully categorise these indicators as, on the one hand, measures of resource inputs to "high technology" activity and, on the other, measures of output or performance of high technology firms.

The most common measure of inputs used is that based on R&D intensity, creating proxy indicators such as R&D

expenditure as a percentage of total industry sales/net output/gross value added/turnover or other similar measures of "output" (Butchart,1987; Hall et al.,1987; Mansfield,1988; Pavitt,1979; Rees,1979). Problems arise, however, due to the paucity of official standard information on R&D expenditure across all industrial sectors (eg.Hall et al.,1987). Also, various anomalies occur such as new small firms and industries appearing to be more R&D intensive, due to being in early stages of product development with initial sales underdeveloped (Monck et al.,1988). At the other extreme is the petrochemicals industry with vast sales to compare with its relatively small R&D expenditure. Such anomalies are part of the problem with input measures which are purely **quantitative** in nature.

In contrast, the importance of the **qualitative** aspect of R&D must also be recognised, and has been by the team involved in the design of the survey questionnaire for the UKSPA/Peat Marwick McLintock survey of all UK science parks (Wield and Quintas,1986; see Monck et al.(1988) for full results and analysis of survey[5]). Within the survey, questions were put to firms about the technological content and relative novelty of their products, and/or the knowledge input to their services, in addition to questions on amounts of R&D expenditure. For example, firms were

[5] Despite the recognition of this important aspect to R&D expenditure as an indicator, and its use in defining "high technology", Monck et al. (1988) argue that the definition of "high technology" is in fact chosen for them by their subject matter, namely, "firms located on Science Parks" (op.cit.,p.129 and p.140). Such an example precisely highlights how operational considerations often override conceptualisation in discussions and definitions of "high technology".

asked whether they were engaged in "radical" new research or merely developing "new" or "complementary" product ranges. From this, Wield and Quintas (1986) were able to conclude that firms on Science Parks were "R&D intensive" based on R&D expenditure levels but, in addition and significantly:

> "...that, if anything, most Science Park firms are, in their modest way, diffusing and applying new technologies into the economy rather than being technologically "leading edge" - [and that] this may be where the economic impact of Science Parks really lies."(op.cit,p.53)[6]

A further input measure commonly used is that based on occupational structures of industries, such as the proportion of an industry's labour force which is in technical occupations (Butchart,1987; Hall et al.,1987; Markusen et al.,1986; Monck et al.,1988). Problems again arise particularly as to the classification of "technical" and the availability of industry-wide data (Butchart,1987). Also, once again, Harris and McArthur (1985) argue that such an aggregate statistic, like R&D expenditure, is misleading and needs to be combined with qualitative data as to the **type** of work "technicians" are involved in, and how this relates to the particular technology in question (op.cit.,p.34).

A variety of measures of output are also used. One example is product sophistication (Vinson and Harrington,1979) and

[6] See Massey, Quintas and Wield (forthcoming) for greater discussion of this issue and the relationship between technology and economic development more generally.

other examples are rates of innovation and patenting activity (Monck et al.,1988; Oakey et al.,1982; Patel and Pavitt,(1987); Pavitt,1980). A further output measure, linked to initial views of "high technology" industry as the industrial saviour, is rates of growth in employment. Yet it has already been seen that "high technology" industry has not lived up to certain early expectations concerning its job generation potential. However, this measure does serve to highlight the circularity evident within many attempts to define and measure "high technology". As Markusen et al. (1986) write:

> "Fundamentally, this approach contains a serious conceptual error. It is based on the tautological notion that since high tech industries are anticipated to be rapid net job generators, they can be *defined* by this performance." (op.cit.,p.13, authors' emphasis)

Thus, a variety of both input and output measures have been used in the quest for a definitive "objective" list of "high technology" industries. But, as Button (1988) has noted, the dichotomy between "objective" and "subjective" can itself be misleading. For he points out how lists created by the use of "objective" measures are then dissected using "subjective" cut-off points. For example, Breheny et al. (1985) chart the attempts of Langridge (1984) to apply Hall and Markusen's (1982) definitional criteria of "all industries and services which over a ten-year period had exhibited a 2 per cent per annum growth rate in employment" and those "with a ratio of production workers to total employment 20 per cent below the national

average". As Button (1988) suggests, this does beg the question, why 2% growth rate and why 20% below the national average.

Similarly, Butchart (1987) puts forward that:

> "An industry becomes a candidate for inclusion in the high technology grouping if its R&D intensity is above the average for manufacturing industry as a whole and it will automatically be included if its intensity is substantially above the average..."(op.cit.,p.84)

He recognises the problem of defining just what is meant by "substantially above" the manufacturing average and decides on a cut-off point of 20%. However, it is important to recognise that this is an "arbitrary" cut-off point within a wider methodology using "objective" indicators.

The SIC system

Even when, and if, "objective" indicators of "high technology" can be agreed upon, their use to produce a list of "high technology" industries is still highly problematical. For such indicators are often applied to select particular (high technology) sectors from lists drawn up using the Standard Industrial Classification (SIC) system which is itself flawed.

It has already been seen how industry may be viewed on the basis of its product and/or its process of production (pp.30-31). The SIC system takes as its basis the final

product but, the Minimum List Headings (or Activity Headings) it creates are broad categories so that within any heading significant **inter-firm product heterogeneity** may indeed be occurring. For example, in MLH 364, radio and electronic components, firms involved in the production of "low technology" radio valves are classified along with those involved in the production of solid state circuitry (Hall et al.,1987,p.19).

Moreover, **intra-firm heterogeneity in the production process** may also be disguised through classification by product. The work of Hymer (1975), Massey (1979; 1984) and Lipietz (1980), amongst others, has identified how establishments within the same firm, producing the same product, may be set within a functional hierarchy. Establishments may often each be involved in different separate stages of the production process ranging from R&D to basic assembly. Indeed, such corporate "spatial structures of production" can, at an aggregate level, create a distinctive "spatial division of labour" based less on product specialisation (ie.the basis of SIC) than functional specialisation (based on relations of production) [Massey, 1984].[7]

So, a multi-site firm may be classified as "high-technology" by its product and, hence, all its establishments will also be so classified. However, in reality, some establishments, due to their position in the functional hierarchy, may be involved in parts of the

[7] Massey (1988) has recently suggested that the newly emergent UK spatial division of labour can be conceptualised as integrating both sectoral and functional specialisation in a new and different form.

production process involving virtually no "high" technological content and, for example, consequently have employment structures heavily dominated by unskilled labour. Examples of such cases have been documented within the US semiconductor industry whereby Silicon Valley is the R&D centre for a multi-national production process which includes unskilled assembly plants in South-East Asia (Henderson and Scott,1988). Furthermore, it is also feasible that a similar situation of process heterogeneity may occur between different production lines within the same establishment. The SIC system, however, classifies establishments on the basis of their (or their firm's) major product.

Heterogeneity may also exist between firms involved within the production of a single "high technology" product (ie.**inter-firm heterogeneity in the production process**). Firms may specialise in a particular part of the production process of a product. The nature of that product will see them defined as "high technology" but, just as individual establishments within a multi-site firm may not actually be involved in a technologically sophisticated production process, so such independent firms may also fit this scenario. Indeed, this may become an increasingly important factor to consider if, as proponents of "flexible specialisation" believe, we are seeing the disintegration of large firms and the creation of small specialist subcontrators in their place (see Chapter Three).

A final problem with the SIC system, other than general problems of data collection which plague all the major

social surveys, is that the classifications are temporally static (at least over the medium term). With the constantly changing nature of technology, SIC, relating to previous industrial composition and technology, may well hide current industrial activity changes which may be quantitatively minor but qualitatively major (Harris and McArthur,1985). The most obvious example of this at the present time is the growth of "biotechnology" (OTA,1984; Sharp,1985), leading the author of the official UK definition of "high technology" industries to write:

> "...that statisticians have yet to discover and define a biotechnology industry, even less to collect statistics for it." (Butchart,1987,p.85)

The continual "progress" of technology implies that a definitive list of "high technology" industries is unlikely ever to appear as there can be no temporally static list of high technology industries (Glasmeier,1985).

"Choices" in definition

In conclusion, it has been briefly outlined how the interplay of both conceptual and operational issues can open up the potential for widely differing definitions of "high technology". Such definitions, once deconstructed, are revealed to be based on a series of key "choices", often conceptualised as dualisms. In turn, significantly different estimates of "high technology" employment arise from the particular compilations of choices which are made.

Take, for example, the difference between Butchart's (1987) estimate of high technology employment in 1984 of 1,249,000 and Hall et al's (1987) figure of 879,800 (see earlier, pp.28-29). These employment estimates were based on definitive lists of "high technology" industry (see Table 2.1), yet what may surprise the reader is that both Butchart (1987) and Hall et al. (1987) used the same definitional criteria for their widely differing lists.[8] Two major differences in the final lists can be seen which account for the difference between the two "high technology" job estimates.

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[8] Butchart (1987) used R&D intensity - measured by ratio of intra-mural expenditure to industry gross ouput - as the first indicator. Any Activity Heading with a figure 20% above the UK manufacturing average was automatically defined as high technology, with those Activity Headings with an above average figure also becoming candidates for inclusion. A second measure was then employed to assess these "candidates". The second measure was those Activity Headings with a ratio of administrative, technical and clerical (ATC) employees to operatives above the UK manufacturing average, a proxy measure for the proportion of scientists, professional engineers and technicians in the labour force. Butchart found that no "candidate" on R&D intensity had a below average score on the second measure thus he included them all in his definition. Indeed, none of the Activity Headings already chosen had a below average figure with all but one having a substantially above average figure.

Hall et al. (1987) firstly identified MLH sectors (ie.1968 SIC) with above average percentages, for British manufacturing industries, of engineers, technologists and scientists. An initial definition of 36 manufacturing and 10 service MLH's was arrived at. A "core" group of 7 MLH manufacturing industries which had "relatively high" R&D expenditure was then further isolated to complete the final list. Hall et al. explain the problems they had with this second indicator such as the unavailability of R&D expenditure figures for all service MLH's as well as many manufacturing MLH's. In fact, some of this data was not available for 3 of the 7 manufacturing sectors chosen by Hall et al. so that these sectors were chosen purely on the basis of one indicator, % skilled occupations. Yet, strangely, 2 of these 3 chosen sectors have lower skilled occupation percentages than other sectors not chosen. No explanation can be found for this leading to the puzzling conclusion that there is no logic, at least in terms of the indicators used, to the final choice of sectors.

TABLE 2.1 A comparison of Hall et al's (1987) and Butchart's (1987) definitions of high technology industries

Hall et al. (1987) definition of high technology industries based on 1968 SIC

MLH	Industry description
272	Pharmaceutical chemicals & preparations
363	Telegraph & telephone apparatus
364	Radio & electronic components
365	Broadcast receiving & sound equipment
366	Electronic computers
367	Radio, radar & electronic capital goods
383	Aerospace equipment manufacturing

Source: Table 2.3 Hall et al. (1987)

Butchart (1987) definition of high technology industries based on 1980 SIC. Those industries in bold also represent the updated 1980 SIC equivalents of Hall et al's (1987) classification.

SIC	Industry Description
2514	Synthetic resins & plastic materials
2515	Synthetic rubber
2570	**Pharmaceutical products**
3301	Office machinery
3302	**Electronic data processing equipment**
3420	Basic electrical equipment
3441	**Telegraph & telephone apparatus & equipment**
3442	**Electrical instruments & control systems**
3443	**Radio & electronic capital goods**
3444	**Components other than active components mainly for electronic equipment**
3453	**Active components & electronic sub-assemblies**
3640	**Aerospace equipment manufacturing & repairing**
3710	Measuring, checking & precision instruments & apparatus
3720	Medical & surgical equipment & orthopaedic appliances
3732	Optical precision instruments
3733	Photographic & cinematographic equipment
7902	**Telecommunications**
8394	Computing services
9400	Research & Development

Source: Table 7, Butchart (1987); Table 2.4, Hall et al. (1987)

Firstly, Butchart (1987) has included 16 manufacturing sectors in comparison to the 7 of Hall et al.(1987). Secondly, Butchart (1987) includes 3 service sectors whereas Hall et al.(1987) have only one.

Also, Preston et al.'s (1985) estimation of employment in the information technology industries can be seen as comparatively high due to two key choices in particular. Firstly, the inclusion of IT services (infrastructure) as well as IT producers and, secondly, the inclusion of "old" IT industries such as printing and publishing as well as the more familiar "new" IT industries such as electronic data processing equipment and radio and electronic capital goods (op.cit.,p.4).

Hence, further inspection of "high technology" job estimates has provided some "explanation" for their numerical variance. Yet, ultimately, it has merely revealed a series of critical choices within the process of definition. What it has not explained is why these choices exist and on what basis these choices are made. The preceding deconstruction of definitions of "high technology" does not, ultimately, explain why such varied views (choices) of "high technology" should exist in the first place.

2.3 "Theory-Laden" Definition

Harris and McArthur (1985), however, provide an explanation while putting forward a solution to the problems of definition of "high technology". They argue that rather

than:

> "...chasing the chimerical and unobtainable definition of high technology and subsequently attempting to justify the inclusion of specific industrial sectors into such a vague and loaded framework, those whose aim is to analyse the genesis and impact of so-called high technology industry should, we believe, look afresh at the subject." (op.cit.,p.7)
>
> "In particular, there has been a failure to explore the different **structural roles** played by different kinds of technology..." (ibid.,p.34, my emphasis)

Thus, this fresh look should involve an attempt:

> "...to relate the work on new and expanding industries in which new technology is apparently important to a theoretical framework which considers the role that technical change plays in economic development." (Harris and McArthur,1985,p.2)

Harris and McArthur (1985), in particular, put forward "long wave" theory as giving:

> "...insights into the links between technological innovation and economic development which enable us to interpret "high technology" more clearly." (op.cit.,p.8)

Harris and McArthur (1985) are quite correct in arguing that, fundamentally, any approach to "high technology" definition must explore and identify the **structural role** of any particular technology included in such a definition, whether it be based on long wave theory or other theories

of structural change (see Chapter Three). This is the critical conceptual step, such that definition is based on **structural characteristics** which arise from the role assigned to "high technology" in any such theory.

However, Harris and McArthur (1985) overstate the case that attempts to define "high technology" have failed in this conceptual step. Certainly examples can be found but it is **precisely because definitions have been influenced (if only implicitly and often only partially) by views of the role particular technologies are deemed to be playing which explains fundamental differences in definition.** It is this influence which explains the existence, and taking, of those "choices" which determine the variety of definitions of "high technology" to be found.

This critical point can be exemplified by a return to the "objective" indicators of "high technology" outlined earlier. It was seen that such indicators are based on identifying *a priori* characteristics of "high technology". However, what must be recognised is the "**theory-laden**" aspect of such a process. Such a process takes place within a preconceived notion of just what "high technology" is and hence, what its characteristics are likely (ought) to be. So, for example, rate of employment growth as a characteristic of "high technology industry" was soon rejected. However, its initial choice as a possible definitional characteristic highlighted the tautological conception that, because "high technology industry" was theorised as a job generator so "job generation" could be

used as an indicator itself (see earlier,p.39). Similarly, R&D expenditure and innovation rates, including patent activity, have been put forward as indicators becauselong wave theory characterises new technologies as part of highly innovative industries acting as the motors of structural economic change (see Chapter Three). The failure Harris and McArthur (1985) expose is a general failure, systematically and consistently, to relate theory to (both quantitative and qualitative) indicators when defining "high technology", rather than the total absence of any theory view of a technology's role in structural change. In other words, the failure to be **explicit** about the theory which underpins any attempt to define "high technology".

Ultimately, it is only through specific theories of economic change which identify the process of technical change as a key factor, that the need to classify "high technology" has arisen. Within such theory "high technology" is assigned a particular (often critical) role as part of the process of technological change. It is this role (whether explicit or implicit) which subsequently sets the definitional parameters within which the search for the litmus paper test for "high technology" can, and has been, carried out.

2.4 Definition and Theories of Structural Change

Recently, Aydalot and Keeble (1988) have provided an (explicit) example of the use of theories of structural change in "high technology" definition. In their work they

contrast two approaches to the study of "high technology":

> "Emphasis can either be focussed on the <u>special</u> nature of new activities and the types of changes which they engender in society: or on the degree of <u>rupture</u> with previous technologies and forms of social and economic organisation which they cause. In the former case, the focus is on the nature of change, in the latter, on the amount of change." (op.cit.,p.4,authors' emphasis)

Following this line of thought Aydalot and Keeble (1988) view the "special" nature of change as being encapsulated in the:

> "...transforming [of] an economy which was based on the production of material goods into a machine for the creation and transfer of information...It is therefore easy to argue from this side the case for the originality and specificity of current new technology, as well as for its particularly powerful and widespread impact..." (op.cit.,p.4-5)

This interpretation, therefore, concentrates on the "information technology revolution" with a resultant list of "high technology" industries based on IT industries and services. Equally this:

> "...first interpretation does not point to identification of high-technology activities on the basis of the level of research and development activity, or of new technology, involved. Rather, it suggests that they should be defined in terms of the degree of upheaval they engender in individual and

> collective behaviour, in the sphere of work as well as in daily life." (Aydalot and Keeble,1988,p.6)

In contrast, the second approach concentrating on the degree of "rupture" is seen by Aydalot and Keeble (1988) as the view of "high technology" put forward in long wave theory (see Chapter Three). Theorists from this position believe that we are presently moving into the fifth Kondratiev cycle of a series of economic development cycles, each based on, and characterised by, a new and different technology:

> "So from this perspective, it is not a question of an historically-unique change resulting from the development of a totally new technology which has divided European history into two periods - before and after the information technology revolution - but rather one of major <u>periodic</u> technological, economic, and indeed spatial, re-alignments." (op.cit., p.5, authors' emphasis)

Hence new technology and its continuous appearance is part of:

> "...more deeprooted economic, social and spatial processes [which] predate the development of new information technology, which is no more than the catalyst or driving force for a new cycle." (Aydalot and Keeble,1988,p.5)

So this approach, concentrating on innovation as a significant indicator, similarly includes micro-electronics and other IT industries in a definition of "high

technology" industries but, also, further industries which have appeared in the last few decades such as aerospace and biotechnology.

Thus, Aydalot and Keeble (1988) provide examples of how theories of structural change may determine lists of "high technology industries" through the (theory-laden) indicators chosen to derive such lists. In fact, their appraisal actually underdevelops this crucial component to "high technology" definition. This underdevelopment stems, in one sense, from their initial conception of theories of change as focussing on either the "special nature" of change or "amount" of change incorporated in the "degree of rupture". For this dichotomy cannot be maintained convincingly because the "amount" of change is an essential and integral element of the "nature" of change. So, in effect, the "information technology revolution" is analagous to the "long wave" approach, in that **they are both theories of periodic change** involving "rupture", even though the time scale may be of a longer dimension and the "rupture" much deeper in the former case. Theories of structural change involve elements of both the "nature" and "amount" of change and Aydalot and Keeble (1988) have merely taken two different theories of periodisation, of structural change, and their different points of emphasis. Other theories of structural change also exist complete with their own emphases on particular aspects of "rupture" (see Chapter Three).

The other sense in which Aydalot and Keeble (1988) underdevelop the importance of theories of structural

change in definition is in their summary of long wave theory and its view of "high technology". As Keeble (1988) writes in a further article in this edited edition:

> "The approach adopted here follows the second of the two alternatives identified [ie.based on long waves], where all radically new technologies which have appeared in recent years, and not just those in the information technology field, are viewed as potential contributors to the development of a new long cycle of economic growth. It also therefore logically focusses on the impact of significant innovations in creating new products and industries, and the essential role of research and development personnel and expenditure in this process." (Keeble,1988,p.70)

So Keeble (1988) goes on to argue that Butchart's (1987) definition of "high technology", with its use of R&D intensity and labour force (technical) characteristics, is the most up-to-date and appropriate definition of "high technology". However, it is precisely this approach of using "surrogate criteria" based on aggregate statistics which Harris and McArthur (1985) have so strongly criticised. Its use within a long wave perspective, a perspective which in their view permits the avoidance of just such an approach, must be rather disheartening.

Harris and McArthur (1985) use the links made by long wave theory between technological innovation and economic development to distinguish between two different sets of technologies, often generically grouped as "high technology". On the one hand are the "widely diffusing

technologies" such as micro-processors in products, electronic office machinery and this category's wider extension as information technology. Such technologies are particularly related by the similar and major roles they are playing in the current downswing. On the other hand are the "newly emergent technologies" such as novel materials, biotechnology and alternative energy technologies. However, the crucial distinction to be made about this second set of technologies:

> **"...is that the newly emergent technologies have little impact upon the structure of the economy at present."** (Harris and McArthur,1985,p.33,authors' emphasis)

This approach, then, does make distinctions within "all radically new technologies which have appeared in recent years" (see Keeble,1988,above). Indeed, it deliberately sets out to avoid such a conflation (Harris and McArthur,1985,p.33).[9]

So, Aydalot and Keeble (1988) may not go far enough in appraising the role of theories of structural change in definition, particularly within long wave theory, but they have crucially recognised such theory's place in any attempt at definition. **Indeed, it is on the basis of theories of structural change that fundamental differences in definitions of "high technology" arise** and that, in conjunction with problems of

[9] The work of Freeman et al. (1982), and their conception of "new technology systems", also highlights the differentiation within "new technology" which does occur within long wave theory (see Freeman,1986,p.110 also).

"operationalisation", a variety of figures for "high technology" employment in the UK are put forward.

Within such theory, the appearance of particular (high) technologies, and their associated industries, has been conceptualised as part of an on-going **process** of (structural) economic change. Subsequently, it is the role ascribed to different kinds of technology as **elements of this change** which has acted as the definitional criterion for particular groups of technologies, and determined the choice of indicators which attempt to exhibit this criterion. Certain groups of technologies, connected by their common place within particular forms of change, have also, subsequently, been labelled as "high technology".

2.5 "High Technology" as a Process of Change in Production

The explicit recognition of "high technology" as a process of change holds two major repercussions. Firstly, the re-definition of "high technology" as a (group of industries related by and representing a) process of change holds a major repercussion when discussing the effects (outcomes) of "high technology". For such outcomes, often grouped as a "pattern", are related by the process (of technological change) **causing them as** outcomes and not necessarily their **similarity (or not) as** outcomes. This distinction represents a critical differentiation between a "pattern" as a (causal) group of outcomes whose members may be either similar or different but which actually relate to each other structurally or causally, and a "pattern" as a group

whose members share similar (formal) attributes but which need not actually connect or interact with one another (Sayer,1984,p.221).

This distinction is critical because the recognition that similarity of outcome is not the automatic result of a single/common process of change highlights that, whilst a process of (technological) change (as encapsulated within "high technology") may be taking place, the operation of such a process will be mediated by other contingent conditions, possibly producing a wide (and potentially contrasting) range of effects (eg.job growth or job loss). Indeed, the insertion of technology within the wider context of the social relations of production, as occurs within theories of structural change, precisely illuminates just such an array of conditions.

By firmly placing (high) technology within a theoretical structure which (i) theorises the role of technological change in economic development and (ii) places technological change within a historical perspective, much greater understanding of the likely **(varied)** impact and implications of "high technology" can be gained (Harris and McArthur,1985).

Technological change and employment: Another look

It can be seen that such impacts go much wider than merely employment levels within a select few industries. If one concentrates on those jobs alone then the **type** of jobs they are as well as their number becomes important. But the

impact of (high) technology is much wider than this. It represents a process of change which creates ripples, even waves, throughout the wider economy, throughout all industry.[10] For analysts of industrial development, two particular implications of technological change have dominated debate based on, firstly, the effect on employment levels and, secondly, the effect on skills in employment.[11]

The impact on numbers employed

The debate on employment levels has seen wide-ranging views of the impact of new technology revolving around the central concept of "displacement". The arguments are about whether or not the jobs displaced by the widespread diffusion of new technology, and in this contemporary period microelectronics in particular, will be compensated for, or exceeded by, the numbers of jobs created by the new technology.

One extreme view forsees the collapse of work and the need for society to re-define exactly why we work, what work will involve and indeed the need to work (Jenkins and Sherman,1979). Post-industrialists[12], such as Bell (1973),

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[10] The impacts of technological change are also much wider than the narrowly economic impacts being addressed here. Some further examples are the impact on the urban form and notions of the "wired city", the rise of new forms of consumption patterns such as tele-shopping and, the particular focus of this thesis, the new geography of production.

[11] Whilst Braun and Senker (1982) provide a concise and structured summary of the history of this debate, the edited collection by Wood (1989) serves to highlight that this debate is still highly relevant, if only in its new guise as part of the "flexibility" debate.

[12] The term is used loosely but, like so many terms in social science, it is

Toffler (1980) and Stonier (1983), believe that the major structural trend of decline of manufacturing jobs, including ultimately those in the new industries, will be advanced by the latest technologies such that:

> "In 25 years it will take no more than 10 per cent of the labour force to provide us with all our material needs."
>
> (Stonier,1983,p.122)

Long wave theorists, in comparison, view the new technology industries as being important sources of job creation. However, such job creation is also combined with job displacement by the same technology. Whether or not job creation outweighs job displacement is dependent on the particular phase of the long wave being studied. Thus, Harris and McArthur (1985), in their application of long wave theory, argued that the UK was experiencing increased mechanisation during the early 1980s through the adoption of new technologies. With the UK economy, at this time, within the "downswing" phase such technologies were principally being introduced for the short-term benefits of reducing operational costs in the face of an economic climate of stagnant demand:

> "The growth of these "high technology" industries is, therefore, associated to a considerable extent with the rationalisation taking place in other sectors." (Harris and McArthur,1985,p.17)

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lacking a tight definition. For a critique of "post-industrialism" see Neuberg (1975).

Hence, job growth may well have occurred in some of the "high technology" capital goods industries, but have been founded upon a wider automation dynamic throughout industry which has entailed job loss.[13] This is exemplified by the case of microelectronics technology. Northcott and Walling (1988) estimate the job loss due to automation based on microelectronics as 45,000 jobs a year between 1983-1987 and 15,000-20,000 jobs a year during the period 1981-1983 (quoted in Large,1988). However, Harris and McArthur (1985) go on to suggest that:

> "There is every reason to believe, for example, that contemporary **widely diffusing** [eg.microelectronics] technologies will constitute a major part of the technological web of a future upswing..." (op.cit.,1985,p.35,authors' emphasis)

Thus, the group of new industries based on these technologies will, during an upswing, become interlinked within "virtuous circles" resulting in a job-generating technological system involving considerable employment expansion. Indeed, the work of Freeman et al. (1982) provides just such a historical example of job growth based on the the previous technological system of electronics.

Yet, whatever the balance of jobs created and jobs displaced, there is a further issue to technological change. The jobs created by new technology are not the same type as those being lost by the introduction of that same technology. The introduction of new technology also implies a shift in the skills required to work with such

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[13] See Kaplinsky (1984) for a comprehensive account of the recent move to automation.

technology.

The impact on skills required

Braun and Senker (1982) summarise the debate on the skill impact of new technology as condensing around three particular positions. Firstly, and deriving ultimately from Braverman's (1974) thesis, is the view that overall **deskilling** will occur. Monopoly capitalism will continue to use technology to increase productivity. Thus, the continued extension of the technical division of labour and automation of the production process will take place, involving the removal of any remaining autonomy and control from a homogenised deskilled workforce.

Secondly, there is the view that the introduction of new technology will result in the **upgrading of skills.** Machines will become more sophisticated hence so will the skills of those required to work such machines. Equally, the continued structural trend to services will increase the total demand for skills as such occupations require greater skills (Braun and Senker,1982). Most recently, the rise to prominence of the "flexible specialisation" thesis of Piore and Sabel (1984) has given this view further impetus (see Chapter Three).

The final view of the effect of new technology, and one which is also receiving a great deal of attention in the discussion of "high technology", involves elements of both skill upgrading and deskilling. This view is the "polarisation" or "declining middle" scenario (see

Pahl,1988, on the variety of actual possible scenarios under the term "polarisation"). It is suggested that the skill structure (and subsequent occupational structure) is bifurcating between an increasingly skilled elite involved in the design, programming and maintenance of the new technology, in contrast to a deskilled, unskilled mass of operators. "High technology" is leading to an:

> "...upgrading of a minority of workers and rapid growth of professional sectors, while a majority of workers are deskilled and reduced to low-paying jobs, either in labor-intensive services or in down-graded manufacturing [causing a] disappearance of the middle class." (Castells,1985,p.23., quoted in Klak,1989)

Klak (1989) has, however, argued that evidence for the "high-technology work force polarisation" scenario is ambiguous and limited and is predominantly based upon overdrawn theoretical generalisations. In a review of the argument in the USA, s/he presents the scenario as being based on the merging of two types of evidence. Firstly, evidence from the occupational characteristics of the semiconductor industry and, secondly, evidence of occupational polarisation within the US economy as a whole, put forward by Bradbury (1986), Loveman and Tilly (1988) and Thurow (1984) amongst others.

The former evidence comes from studies of the semiconductor industry such as Saxenian's (1985) study of Silicon Valley (see also Scott,1988b; 1989). The dominance of the industry has been so great within the region that:

"Silicon Valley's urban landscape has thus come to mimic the microelectronics industry's bifurcated social structure. The large and affluent professional-managerial strata of the industry's workforce is insulated in the north and west...with easy access to the electronics complex. Meanwhile, the industry's large, low-income production workforce is concentrated further to the south and east..." (Saxenian, 1985, p.87)

Similarly, Scott (1989), in his study of "The Technopoles of Southern California", argues how the region's "high technology" industrial base is resulting in:

> "A definite restructuring of local labor markets, with two distinctive strata becoming increasingly evident. On the one side, there is a stratum of skilled highly-paid workers... On the other side, there is a rapidly-expanding stratum of low-skilled low-wage workers comprising for the most part females and immigrants subject to great employment instabilities as manifest in high rates of turnover, part-time work and temporary work." (op.cit.,p.6)

In the UK, Kelly and Keeble (1988) have also provided evidence for skills polarisation within "high technology" industry. They found that during the period 1978-84, the UK's computer hardware industry experienced a 5.5% growth in employment. However, this was split between a growth in highly qualified research and development workers of 93% compared to a 20% decline in numbers of unskilled and semi-skilled workers. They also found a similar trend of job growth in skilled occupations and employment decline in

lower skilled occupations within the computer software and services sector (op.cit,p.3-4).

Lovering (1987) has also described a situation of "polarisation", but during a time of job-loss, within the UK electronics and aerospace industries. While these industries shed over 60,000 jobs between 1981-84, during the same period the number of scientists and technologists employed actually increased by almost 8,000 (op.cit.,Table 8).

Concerning the US, however, Klak (1989) has concluded that:

> "Given what appears to be a general trend towards bifurcation in the work-force in the US economy as a whole (for example,Thurow,1984), the results of this study suggest that high technology has been wrongfully accused of being responsible for that polarization." (op.cit.,p.239)

Moreover, s/he also concludes that:

> "In short, as a result of this study, I suggest that under the umbrella of a popularly-appealing concept such as high-technology industry there are a variety of industrial sectors, establishments, and firms, which are likely to exhibit divergent occupational patterns." (op.cit.,p.240)

This conclusion concurs with that reached by Elger (1987) in his review article of recent publications dealing with new technology and the transformation of work:

"Despite these reservations, both authors [Francis,1986; Gill,1985] provide useful overviews of the many case studies of NT, to which must now be added those reported in Purcell et al.[1986]. These new studies not only document a variety of experience which belies any uniform shift towards either upgrading or deskilling, they also reveal the substantial complexity of change even in specific settings, and beyond this they explore some of the sources of expectations and leverage which help to condition the divergent experiences of such change." (op.cit.,p.532)

In fact, both these conclusions merely serve to confirm the point that any:

"...quest for general trends about the development of skill levels, or general conclusions about the impact of technologies, is likely to be in vain and misleading." (Wood,1982,p.18, quoted in Wood,1989)

Thus, it is clear that the impacts of "high technology" as a process of change are varied. Moreover, concrete research must be undertaken to identify the "array of conditions" within which "high technology" is being introduced with such varied results.

"High technology": Its significance as a process of development

The second major implication resulting from the recognition of "high technology" as a process of change concerns its actual **significance as a process of change**. Whilst

this chapter initially began with an attempt to determine the impact of "high technology", in terms of the numbers employed within the industry, it has gone much further. Firstly, it is clear that any such impact is varied and depends on the particular definition of "high technology" taken. But, secondly, it is also clear that the significance of "high technology" is much more than a question of jobs *per se*. Indeed, fundamentally, the issue here is not the definition of "high technology", and subsequent estimation of the numbers employed within its industries, at all. Rather, the issue is the recognition that technological change, and moreover the particular form of change encapsulated by "high technology", matters in the analysis of industrial development.

The particular form of change "high technology" does represent is to be derived from any one theory of structural change, and it is from these theories that "high technology" has gained its significance (out of all proportion to its quantitative presence as an industry). **For within such theory "high technology" is viewed as the harbinger of structural change, more so as part of the process of restructuring. In fact, it is argued that the rise of "high technology" (industry) is nothing less than indicative of a new phase in the historical development of capitalism. Subsequently, the impact of "high technology" may also be viewed as the sign of things to come** (Hall,1981; Leborgne and Lipietz,1988; Marshall,1987; Piore and Sabel,1984; Scott and Storper,1986; Scott,1988a; 1988b).

The preceding discussion of "high technology's" impacts has made clear that the process it represents is also a **process of uneven development.** Yet, an element of this unevenness is still to be discussed. That unevenness concerns "high technology's" impact on the geography of employment, on the pattern of uneven **spatial** development within the UK. This particular impact, as with the others so far discussed, has also been argued to be of critical significance. For, just as distinct forms of uneven spatial development have been characterised as the geographical expression of past economic periods, so the form of uneven spatial development characterised by "high technology" is thus being argued to be indicative of the space economy of the emergent economic era (Hall,1981; Scott and Storper,1986; Scott,1988a; 1988b). Thus, it is to the uneven spatial development, the industrial geography, of the United Kingdom's "high technology" industry that we turn to in Chapter Three.

CHAPTER THREE: Sunrise in the South, Sunrays Stretching to the North: The Geography of Britain's High Technology and Theories of Uneven Spatial Development

3.1 Introduction

This chapter begins with a portrayal of the uneven spatial development of high technology industry. Indeed, emphasising a conclusion of Chapter Two, it is within the geography of Britain's high technology industry, at a variety of spatial scales, that the uneven impact of high technology is most graphically and stunningly illustrated. For whilst the industry nationally has witnessed job loss, this picture hides the mixed fortunes of regions and localities and, in particular, the appearance of the "favoured few" - the high technology growth regions.

Moreover, such variety of growth and decline represents only one dimension, the quantitative dimension, of the uneven development of Britain's high technology industry. The portrayal will go on to highlight the nature of the jobs, as well as the number, being created. And it is through this further dimension that a full picture of the uneven development of Britain's high technology will be gained. For from this may be drawn the uneven development of high technology's **social relations of production:**

> "The fact that one region has jobs only in direct production while another claims all the headquarters, or that areas differ

in their dominant industries, or that in one area the jobs on offer are overwhelmingly manual while in another there is a sizeable slice of white-collar and well-paid employment in research, all these differences reflect different forms of geographical organisation of the relations of production...

...what has been seen simply as the spatial distribution of employment [in terms of numbers and types of job] is underlain by, and can be approached through, analysis of the geographical organisation of the relations of production. In relation to the substantive social sciences the argument is that the social structure of the economy, the social relations of production, necessarily develop spatially and in a variety of forms. These forms we shall call *spatial structures of production*."

(Massey,1984,p.67-68, author's emphasis)

"But why does all this matter? The argument is that *each different kind of spatial structure implies a distinct form of geographical differentiation, of geographical inequality*...Geographical uneven development does not vary only in degree, as some of the arguments about increasing uneven development imply, it varies also in nature."

(op.cit.,p.82, author's emphasis)

3.2 The Uneven Spatial Development of Britain's High Technology Industry: The Number of Jobs

A regional geography

The first overwhelming aspect of the geography of high technology industry is that it exhibits a distinct North-South divide (in common with so many other contemporary indicators).[14]

[14] For the most recent overviews see Champion and Townsend,1990; 1991; Lewis and

In 1981, 59% of Britain's high technology employment was concentrated in the three regions of southern England (South West, South East and East Anglia). The South East alone accounted for 46% of high technology jobs (Keeble,1987). These figures were based upon:

> "...seven unequivocally high-technology Minimum List Heading sectors [which] can be identified on the basis of Kelly's criteria (1986), namely pharmaceuticals, scientific instruments and systems, broadcasting and sound reproducing equipment, aerospace, and electronic computers, components, and capital goods." (op cit.,p.16)

A more recent piece of Keeble's work (1988) [see Table 3.1], using Butchart's (1987) wider definition of high technology industry, similarly illustrated the geographical concentration of high technology industry. Keeble (1988) found over 55% of 1981 high technology jobs were to be found in southern England (South East, South West and East Anglia), compared to these region's 42.3% share of Britain's total population (Crouch,1989 quoted in Champion and Townsend,1990). The South East alone accounted for 43% of Britain's high technology employment. The equivalent figures for 1984 also show no change in the picture of concentration. In fact, the percentage figures show a marginal increase to 56% and 44% respectively.

What is important to note here, however, is how southern England held, if not increased its position, of dominant region within the overall context of high technology job

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Townsend,1989; Smith,1989.

loss. Not only did the years of net job creation heavily favour the South but the suggestion is that in times of job loss the South is losing fewer high technology jobs proportionately than the other regions. As it is, in 1984 over 522,000 high technology jobs were situated in southern England.

TABLE 3.1 The regional distribution of high technology industry in Britain,1981-84

	No. 1981	No. 1984	Change 1981-4	
Region	Employees	Employees	No.	%
East Anglia	30,802	37,231	+6,429	+20.9
Wales	36,926	37,993	+1,067	+2.9
Rest of South East	321,085	322,127	+1,042	+0.3
Scotland	87,695	86,044	-1,651	-1.9
North	46,286	43,864	-2,422	-5.2
Greater London	211,492	200,058	-11,434	-5.4
East Midlands	78,013	73,391	-4,622	-5.9
West Midlands	104,123	97,469	-6,654	-6.4
South West	114,744	105,554	-9,190	-8.0
Yorkshire and Humberside	52,328	46,540	-5,788	-11.1
North West	145,072	127,870	-17,202	-11.9
Great Britain	1,228,566	1,178,141	-50,425	-4.1

Source: Keeble (1988) Table 4.3

In contrast, the North West, containing the second greatest number of high technology jobs in 1981 of any region after the South East (145,000), experienced the highest absolute and percentage decline in high technology employment of any

of Britain's regions during the period 1981-84 (-17,000 jobs or -11.9% respectively).

One other aspect of the figures in Table 3.1 is that, despite the overall context of job loss, the three regions of East Anglia, Rest of South East and Wales experienced **job growth**. East Anglia experienced a dramatic growth rate of over 20%, although from a relatively small base. From a similarly small base Wales also experienced modest growth despite its status as a peripheral (and indeed "assisted") region. Furthermore, Scotland, a region of similar status to Wales, experienced a slight job decline of 1.9%, but even so this figure was half the figure for that of Great Britain as a whole.

However, the overall picture presented by the regional geography of high technology employment is of significant geographical concentration. This impression is further strengthened by the move to the sub-regional scale.

A sub-regional geography

The geographical concentration of high technology industry in southern England intensifies as a step down the spatial hierarchy is taken.

One of the more recent phenomena to catch both journalistic and policy makers eyes has been the notion that Britain has its very own Silicon Valley, namely the Thames Valley or M4 Corridor (The Economist,1982; Feder,1983; Phillips et al.,1983; Thomas,1983). Other regions where high technology

industrial growth has come to the attention have similarly tried to capture the imagery of Silicon Valley. So, for example, we have Silicon Glen in Scotland and Silicon Fen in East Anglia.

The M4 Corridor

One of the first major academic projects investigating the geography of high technology industry was undertaken at the University of Reading. Its aim was to investigate the proposition of the "M4 Corridor" (Hall et al.,1987). The research team initially reviewed the, at that time, sparse efforts made to measure and validate this new high technology "promised land". Previously, Gibbs (1983) and Ellin and Gillespie (1983), using 1971 and 1978 Census of Employment data, had concluded that, as seen above, the South-East had the highest concentration of high technology industry, but also that there was no obviously identifiable M4 Corridor (quoted in Hall et al.,1987). Similarly, an Engineering Industry Training Board report (Tank,1984), based on a survey of its members in the electronics industry and covering the period 1978-1983, concluded that:

> "As far as the electronics industry is concerned, there is no such thing as an M4 corridor and other explanations are necessary to explain the distribution of, and growth in, electronics employment." (Tank,1984)

The report identified seven counties which employed between 10,000-50,000 people in the electronics industry, although four were the south-eastern counties of Essex,

Hertfordshire, Berkshire and Hampshire and a fifth was the metropolitan county of Greater London. However, of the seven counties which showed the fastest **employment growth** during the period only two, Berkshire and Gwent, straddled the M4 Corridor. In fact, the author argued for a "conurbation effect" but with a South-East bias. It was with this backdrop that Hall et al. (1987) investigated the notion of the M4 Corridor as a continuous high technology region, encompassing counties running from as far west as West Glamorgan to Greater London in the east.

Chapter Two outlined Hall et al.'s definitive list of seven high technology manufacturing MLHs (see Table 2.1,p.45). From this definition, and using 1981 Census of Employment data, the team plotted an employment distribution which could be seen to support the conurbation effect suggested in the EITB report. In terms of absolute employment the three metropolitan areas of London (91,000+ jobs), West Midlands (36,500 jobs) and Greater Manchester (27,300 jobs) rated highly, with some surrounding counties, such as Hertfordshire (45,000 jobs), Hampshire (33,800 jobs) and Lancashire (30,000 jobs), also topping the list (Hall et al.,1987,Figure 3.2 and p.32). However, the authors noted that:

> "The dominance of the metropolitan areas in absolute high technology employment reflects, of course, their size as employment centres rather than any particular concentration of high technology activity" (Hall et al.,1987,p.32)

Hence, to overcome this bias and allow measurement of the relative significance of concentrations of high technology jobs, the team undertook a location quotient analysis of the figures (see Table 3.2). Clearly topped by Hertfordshire, but with Avon second, the table gives some credence to the notion of an M4 Corridor but is by no means convincing.

TABLE 3.2 Location quotients (above 1.0) for counties with 5,000 or more high technology jobs, 1981.

County	Location Quotient
Hertfordshire	3.60
Avon	2.32
Fife	2.24
Somerset	2.11
Berkshire	2.08
West Sussex	2.03
Lancashire	2.01
Hampshire	2.00
Derbyshire	1.83
Essex	1.83
Surrey	1.79
Mid Glamorgan	1.76
Dorset	1.69
Clwyd	1.49
Nottinghamshire	1.32
Gloucestershire	1.24
Bedfordshire	1.24
Buckinghamshire	1.15
West Midlands	1.02
Base = GB	

Source: Hall et al. (1987), Table 3.6

However, the Reading team went on to argue that although total employment levels are useful, **employment change** in recent years must be seen as the best guide to high technology activity. Thus, an analysis of absolute employment change was undertaken for the years 1975-1981 with the consequent placement of the metropolitan counties at the foot of the table, and promotion of Berkshire, the "premier" M4 corridor county, to the top of the rankings.

TABLE 3.3 Aggregate high technology employment 1981, change 1975-81, by selected counties, ranked by 1975-81 change.

Rank	County	Absolute Employment 1981	Change in Employment 1975-81	% Change
1	Berkshire	19732	+7600	+62.2
2	Hertfordshire	45060	+5914	+15.1
3	Clwyd	5094	+3283	+181.3
4	Hampshire	33807	+2179	+6.8
5	Surrey	18191	+1811	+11.1
6	Kent	14650	+1679	+12.9
7	West Sussex	14694	+1669	+12.8
8	Bedfordshire	7264	+1653	+29.5
9	Lothian	9042	+1461	+19.3
10	Lancashire	30033	+1392	+4.8
58	Strathclyde	23575	-3847	-14.0
59	Tyne and Wear	8490	-4032	-32.2
60	Essex	24469	-4342	-14.9
61	Nottinghamshire	15860	-5123	-24.4
62	Merseyside	14417	-6435	-30.8
63	West Midlands	36500	-8257	-18.4
64	Greater London	91448	-17012	-15.7
	Great Britain	640874	-42429	-6.2

Source: Hall et al. (1987), Table 3.8

Even arguing for employment growth as the most useful measure, Hall et al. (1987) ultimately agreed with the conclusions of earlier studies:

> "...that there is no identifiable, continuous corridor of high technology industry along the M4." (op.cit.,p.46)

However, the story did not end there. For:

> "In absolute employment terms, Greater London, at the Corridor's eastern end, with 91000 workers in 1981, still dominated the pattern despite massive losses in the preceding years...But the pattern of 1975-81 growth is dominated by Berkshire with 7600 additional jobs, Hampshire with 2200 and Surrey with 1800 - or, outside the Corridor altogether, by Hertfordshire's 5900 additional jobs.
>
> On this criterion the core of high technology activity, and particularly electronics, in Britain is at the London end of the 'M4 Corridor', in a belt running from Hertfordshire to the north-west of London, through Berkshire and into Hampshire and Surrey. It seems more appropriate, if labels are necessary, to refer to the 'Western Crescent': this pattern of high technology industry is not so much a 'corridor' as an arc around west London. Areas to the west of this crescent, particularly Avon and Wiltshire, popularly believed to feature strongly in the M4 phenomenon, show no particular dynamism; even farther west, South Wales generally shows losses in employment in our high technology sectors, rather than gains (Hall et al.,p.47-8, my emphasis)

Hence, the research team at Reading, although denying the

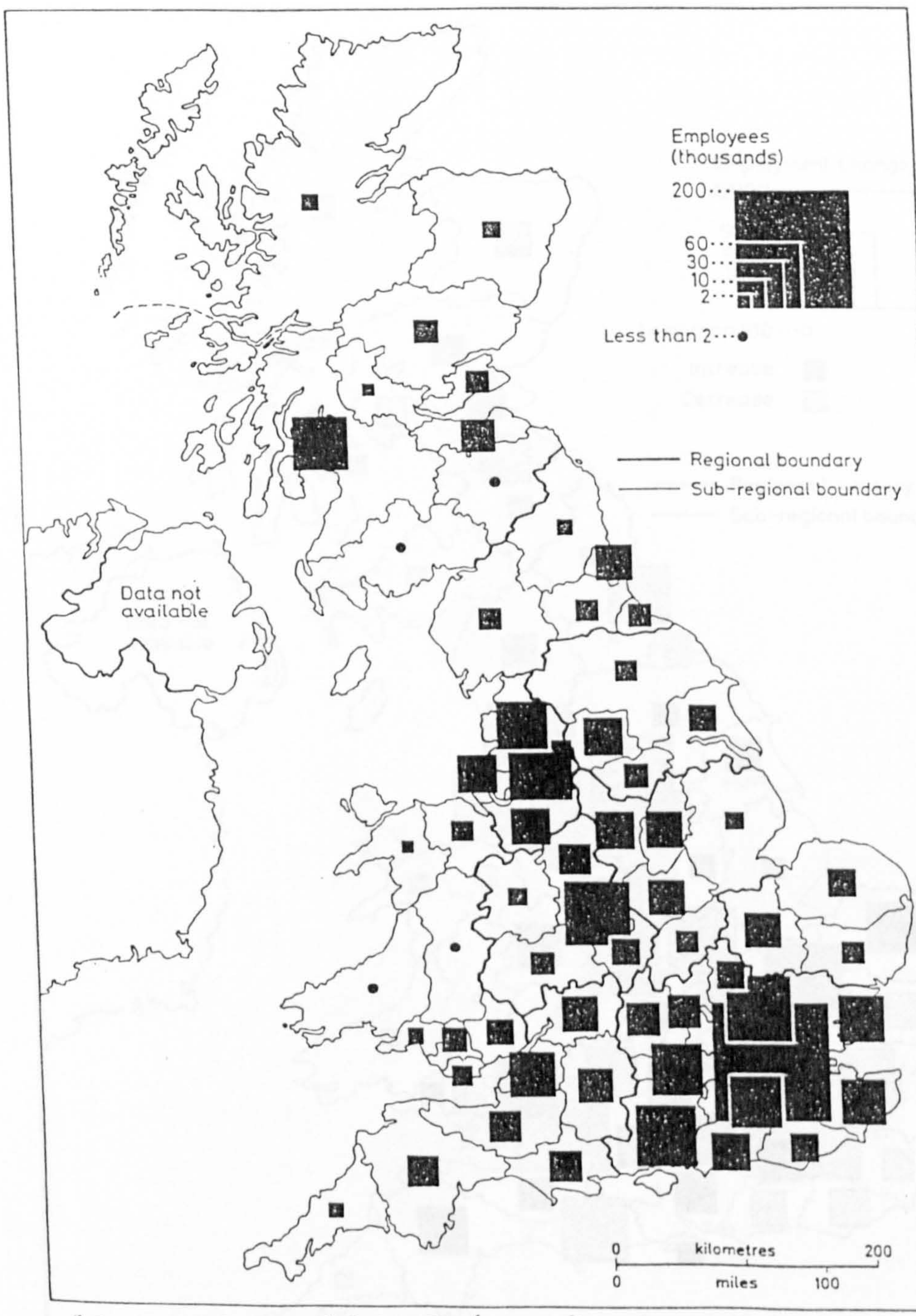
existence of the M4 Corridor, did identify a sub-regional high technology agglomeration within the South East, namely, the Western Crescent.

The existence of this agglomeration has subsequently been confirmed by Keeble's (1988) analysis of the 1984 Census of Employment. Figure 3.1 shows the continued numerical dominance of high technology employment by Greater London but also by Hertfordshire, Hampshire, Berkshire and Surrey - the Western Crescent counties. Keeble (1988) also identifies secondary concentrations of employment in North West England and central Scotland (op.cit.,p.76). Indeed, the map shows that a similar number are employed in the North-West as in the Western Crescent. The difference between the two areas could not be more significant however.

Earlier, whilst discussing Table 3.1 (pp.70-71), it was noted that the North West had experienced the greatest absolute and percentage **decline** in high technology employment of all the regions between 1981-84. This is graphically illustrated in Figures 3.2 and 3.3. In contrast, all the Western Crescent counties saw continued employment **growth**, the indicator Hall et al. (1987) distinguished as the most significant in analysing the geography of high technology.

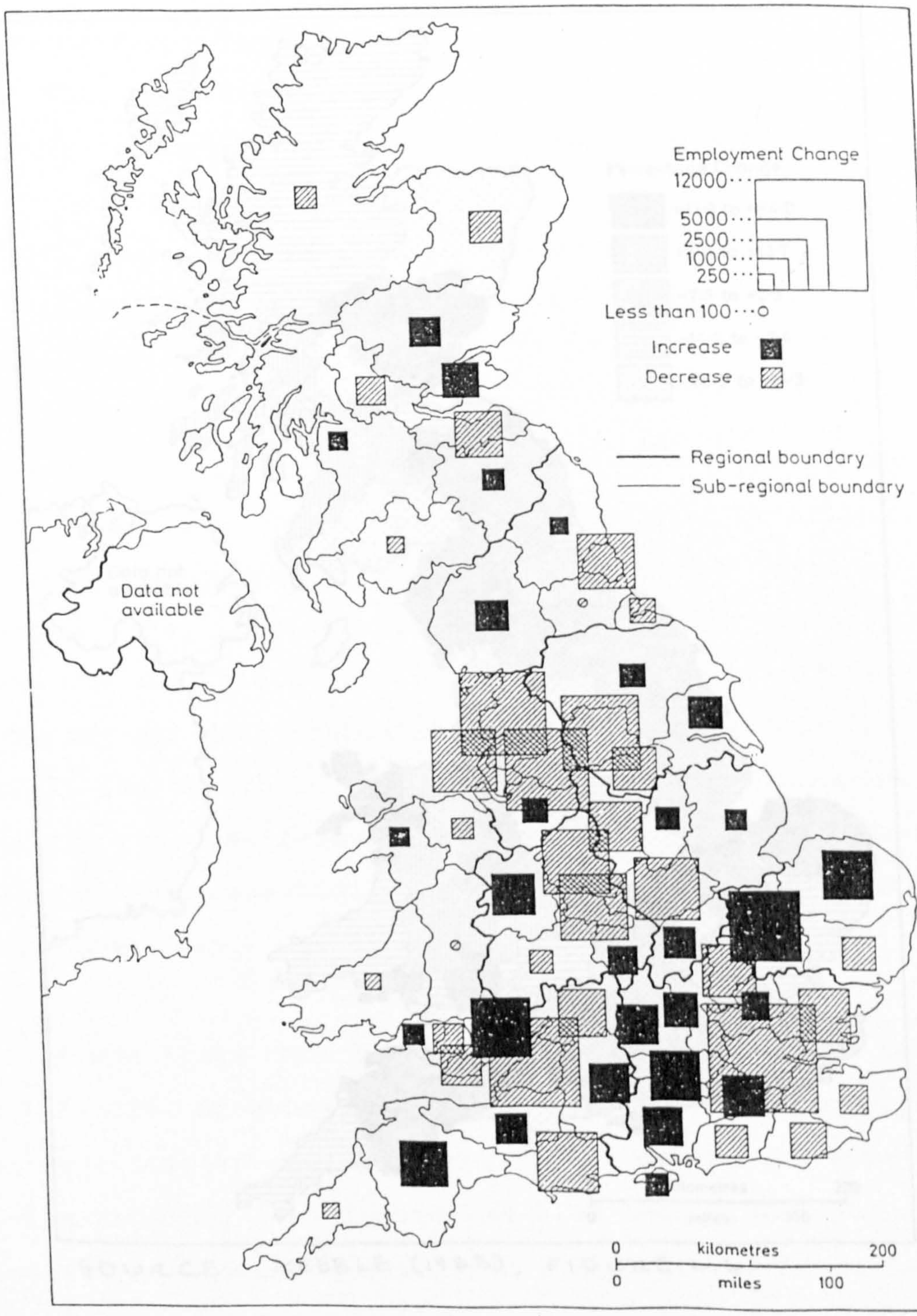
But what of the other so-called high technology agglomerations, Silicon Glen and Silicon Fen. What is the evidence for their existence?

Figure 3.1 The Geographical Distribution of High-Technology Industry in Great Britain, 1984



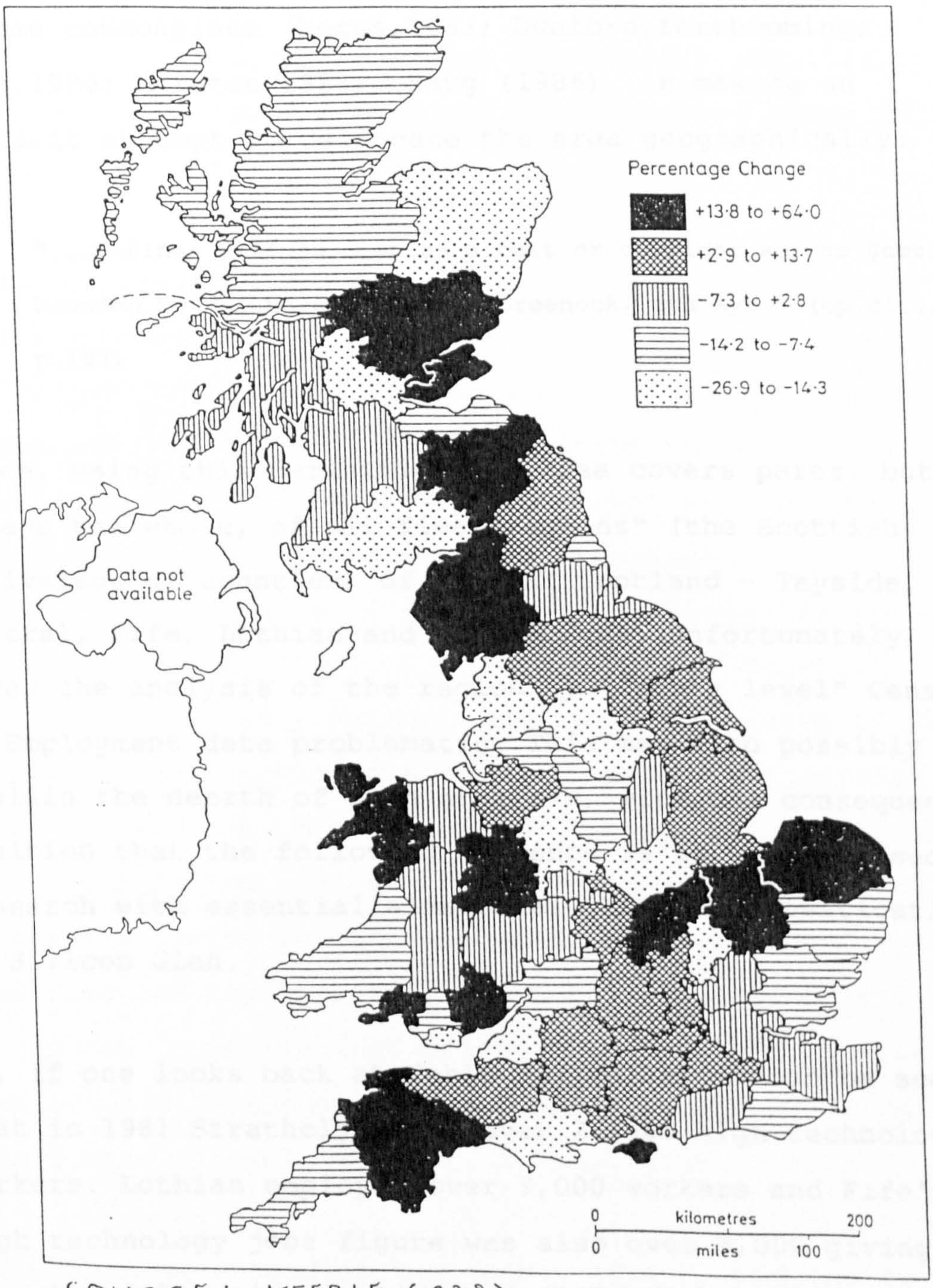
SOURCE: KEEBLE (1988), FIGURE 4.2

Figure 3.2 The Geographical Evolution of High-Technology Industry in Britain, 1981–4, by Volume of Employment Change



SOURCE: KEEBLE (1988), FIGURE 4.3

Figure 3.3 The Geographical Evolution of High-Technology Industry in Britain, 1981-4, by Rate of Employment Change



SOURCE: KEEBLE (1988), FIGURE 4.4

Silicon Glen

The term "Silicon Glen" was first coined in 1975 by the Scottish Development Agency, since when its usage has become commonplace (Berss,1983; Dunford,forthcoming; Haug,1986; Moreton,1981). Haug (1986), in making an explicit attempt to delineate the area geographically:

> "...defines Silicon Glen as a belt or corridor across Scotland bounded by Edinburgh, Dundee, Greenock, and Ayr." (op.cit., p.107)

Hence, using this definition the area covers parts, but not always the whole, of all five "regions" (the Scottish equivalent of counties) of central Scotland - Tayside, Central, Fife, Lothian and Strathclyde. Unfortunately, this makes the analysis of the region by "County level" Census of Employment data problematic. This may also possibly explain the dearth of such analysis, with the consequent position that the following evidence is partially based on research with essential aims other than the investigation of Silicon Glen.

So, if one looks back at Table 3.3 (p.75) it can be seen that in 1981 Strathclyde had over 23,500 high technology workers. Lothian employed over 9,000 workers and Fife's high technology jobs figure was also over 8,000 giving the "county" a location quotient of 2.32, the second highest of any county in Britain. However, on the important criterion of employment growth (1975-81) the evidence was

contradictory with Lothian being ranked ninth in Britain with an employment increase of 1,461 or 19.3%. This contrasts sharply with Strathclyde, ranked 58th out of 64, having experienced a 14% job decline numbering nearly 4,000 jobs. At the same time, a Scottish Development Agency report was quoting the Scottish electronics industry as involving over 200 firms and 40,000 employees (SDA,1981 quoted in Haug,1986).

By 1984, Keeble (1988) was noting the concentration of high technology employment in central Scotland (op.cit.,p.76 and see Figure 3.1). But Figures 3.2 and 3.3 on employment change 1981-84, highlight the variation between the regions of Silicon Glen. Three of the five counties, including the previously declining Strathclyde, experienced employment growth, but the remaining two experienced significant job decline. Dunford (forthcoming) suggests the Scottish electronics industry employs about 42,000 workers in 280 companies, not including additional supply and service companies and employment. Moreover, work by Townsend (1987) has described Scotland's position as the most favoured European location for US high technology investment and predicted the arrival of 3,700 jobs during the period 1987-89 (quoted in Keeble,1988,p.86). This builds on the earlier work of Haug (1986) on the continued investment of US electronics multinationals in Silicon Glen.

Yet such predictions as Townsend's (1987), and the faith behind them, must be treated with a certain amount of caution. For the US electronics industry is renowned for its rapid business cycles and its overseas investment is

also subject to such cyclical trends. Indeed, the recent withdrawal of Wang from Scotland emphasises the need for such caution.[15] Furthermore, whilst many analysts have concentrated on the importance of US multi-national investment to Scotland's electronics industry (Haug,1986; Henderson,1987; Townsend,1987), it must be recalled that:

> "The development of the Scottish electronics industry dates from Ferranti's 1942 decision to open a gyro-gunsight factory in Edinburgh and the development of the instrument makers, Barr and Stroud, in Glasgow." (Dunford,forthcoming,p.81)

Hence, evidence allows the conclusion to be drawn that Scotland, and especially central Scotland, has a significant number of high technology jobs. One may place the rhetorical label "Silicon Glen" upon this development if one wishes. However, most importantly, recent growth must be seen as modest. As was noted earlier, despite Scotland posting the fourth best high technology employment "growth" record of Britain's regions between 1981-84 this actually entailed a **decline** in jobs. Indeed, Scotland's growth is modest in comparison to that of Silicon Fen.

Silicon Fen

The term "Silicon Fen" is used to descibe an area of East Anglia which has seen spectacular high technology employment growth predominantly founded upon "the Cambridge phenomenon", the growth of high technology in Cambridge (Crang,1988; Keeble,1988; 1989; Segal et al,1985; 1986).[16]

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[15] I thank Dave Wield for this particular point.

[16] In fact, it is pertinent to ask whether "Silicon Fen" is actually synonymous

Hall et al. (1987) made no mention of any East Anglian county when discussing high technology employment growth between 1975-1981. No East Anglian county was found to employ over 15,000 workers in high technology or had a location quotient above unity. Yet, between 1981-1984, East Anglia recorded high technology employment growth of 20.9%, an absolute employment growth of 6,429 (Table 3.1,p.70), five times the absolute growth of the second placed region. This regional growth becomes all the more stunning on reference to Figures 3.2 and 3.3 (pp.79-80) which show that Suffolk actually experienced high technology job decline during this period. Such decline was swamped by employment growth in Cambridgeshire and Norfolk, the counties posting **absolute** gains which placed them first and third respectively in a ranking of county high technology employment growth 1981-84 (Keeble,1988,p.80). Since such time growth has continued apace with the Cambridge sub-region, particularly, gaining a further 800 jobs between 1985-86, with the prediction of a further growth of 1,200 jobs for the following year (Segal et al.,1986; quoted in Keeble,1989).

Hence, a descent of spatial scale gives a more nuanced picture of the geography of high technology than simply the North - South divide depicted in regional figures. Rather, this construction acts as an overarching framework within which sub-regional figures characterise, on the one hand, even greater high technology industrial concentration within the South East, namely the Western Crescent and

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with Cambridge and its environs or includes a greater area of high technology growth.

Silicon Fen agglomerations. On the other hand, however, we have also seen that such figures have highlighted high technology agglomeration in the North, particularly, Silicon Glen.

Moreover, Figure 3.2 (p.79) depicts high technology employment growth in almost half of Britain's (29) counties, with 14 counties recording an increase of at least 1,000 jobs between 1981 and 1984 (Keeble,1988,p.80). Indeed, on studying the county figures, Keeble (1988) has concluded that:

> **"...the geography of high-technology development in the 1980s is one of widely dispersed growth in most regions, but with a particular focus on a broad band of southern English counties..." (op.cit.,p.80,author's emphasis).**

This countervailing trend of "dispersed growth" is emphasised by the final spatial scale at which the geography of high technology may be discussed. The growth of Silicon Fen has, as mentioned, been based upon "the Cambridge phenomenon", the growth of a high technology "locality". And it is to the spatial scale of the locality that we now move in the continuing analysis of the geography of Britain's high technology industry.

A geography of high technology localities

In recent years, unsurprisingly, in the light of the rise of the "locality" as an object of study[17], has been

founded a growing body of literature on high technology localities (Boddy et al.,1986; Crang,1988; Gripaios et al.,1988; Keeble,1988; 1989; MacGregor et al.,1986; Rainnie et al.,1989; Segal et al,1985; 1986; Witt et al.,1988). Of the very few overviews of Britain's high technology localities which are to be found, a geographical pattern is described which further confirms the conclusions already reached. That is, that within an overarching North - South divide heavily centred on the South East, there is to be found significant dispersed growth of high technology employment within many counties and locales of Britain, both North and South.

Very few overviews are to be found mainly because the spatial disaggregation of major social statistics has itself only recently been achieved, and then only partially. So, for example, Small Area Statistics derived from the 1981 Census are now available, as is the disaggregation of the Census of Employment to the spatial level of the Travel-To-Work-Area (TTWA). The release of such figures, however, lags even further behind in time than the general results of such censuses. Hence, Townsend's (1986) work on TTWAs between the years of 1978-81 was only made possible when Census of Employment data for such areas became available in 1984. The other problem with small area statistics is the confidentiality restrictions applied to such data so that no individual (household or establishment) may be identified from that

[17] Three recent major research programmes have taken the "locality" as their geographical focus: the Social Change and Economic Life (SCEL) initiative; the Changing Urban and Regional Systems (CURS) initiative; and the Economic Restructuring, Social Change and Locality project.

data alone.

Within these restrictions, several illuminating pieces of research have been undertaken. One such example mentioned above is that of Townsend's (1986) work on employment growth between 1978-81 at the spatial level of TTWAs. In identifying employment growth between these years, Townsend sub-divided this growth into components of growth such as "producer services", "public sector" and "high technology". The first interesting finding was that 195 of Britain's 380 TTWAs experienced high technology employment growth between 1978-81. Thus, this gives a percentage figure of over half (51%) of all Britains' TTWAs (calculated from Table 3,p.536,Townsend,1986). However, taking this figure as the Great Britain average a North-South divide can still be discerned. For those regions above the average are the familiar South East (59%), East Anglia (59%) and South West (54%), but also East and West Midlands (59% and 52% respectively). But, the regions of the "North" have not missed out on the growth of high technology. So, for example, the lowest figures are for the North-West and the North, which still saw 41% of their TTWAs experiencing high technology employment growth, with Scotland seeing 48% of TTWAs growing and Yorkshire and Humberside 50%. Indeed, the four leading TTWAs were spread throughout both North and South; being Dundee (Silicon Glen), Watford (Western Crescent), Macclesfield and Birmingham.[18]

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[18] Obviously, one must be careful here. Due to the small areas being talked about one large investment (or disinvestment) can have an unduly disproportionate impact on the overall figures. However, even if this is the case, it still highlights the dispersed nature of large scale high technology industrial investment.

The locality-based geography of high technology employment has been further depicted by Cooke (1986). Figure 3.4 once again highlights the North-South divide but also the variation within this rather crude characterisation. Interestingly, Cooke (1986), in describing this figure states that:

> "It is important to note that, in terms of aggregate location quotients it is not the M4 Corridor which shows up particularly strongly on this map, rather it is the older established northern outer metropolitan localities of Hertford and Harlow, Chelmsford and Braintree, and Sudbury that form the strongest contiguous concentration. Of equal individual importance thereafter are Slough, Basingstoke and Alton, and Yeovil."
>
> (op.cit.,p.23)

This description is similar to that of the Western Crescent described by Hall et al.(1987). Signs of Silicon Glen can also be identified from the map but, again, what the figure definitely depicts is the regional dispersal of high technology localities.

A further fascinating overview is that by Begg and Cameron (1988). In a piece in which the locality takes the form of "urban areas", they rank British "cities" by **concentrations** of high technology employment as at 1981. The context is set by looking at the regional pattern of high technology employment whereupon, in conjunction with all the other studies mentioned, they highlight that:

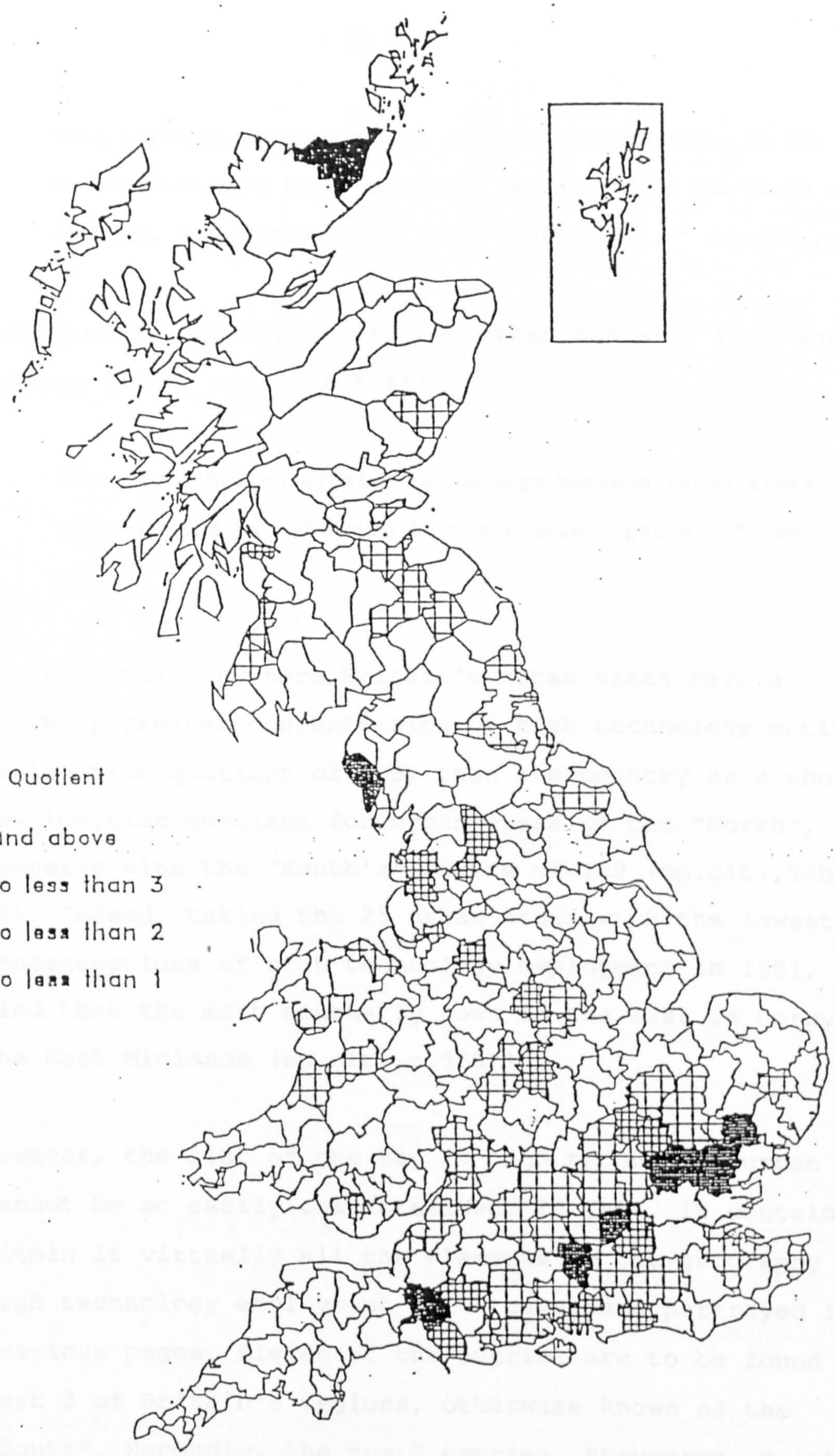

FIGURE 3.4. High Technology Industry by Locality
Location Quotient – All In Employment 1981 – Benchmark=GB

SOURCE :- Cooke (1986), Map 3

> "The striking feature of the regional distribution is the concentration of high technology employment in the South of the country, especially in the outer South-East..." (op.cit.,p.365)

Consequently, on turning to the urban pattern, Begg and Cameron (1988) conclude that:

> "The distribution of high technology between urban areas reflects and is reflected in the regional pattern." (op.cit., p.368)

In the situation where Britain's urban areas have a slightly greater concentration of high technology activity (a location quotient of 105) than the country as a whole, the location quotient for urban areas of the "North", 86, compares with the "South's" figure of 129 (op.cit.,Table 10). Indeed, taking the 25 urban areas with the lowest concentrations of high technology employment in 1981, we find that the most southerly town in the list is Corby in the East Midlands (op.cit.,p.368)!

However, the list of the top 25 high technology urban areas cannot be so easily characterised. In fact, it contains within it virtually all the elements to the geography of high technology employment which have been portrayed in the previous pages. Eleven of the entries are to be found in just 3 of Britain's regions, otherwise known as the "South". Secondly, the top 3 entries, Stevenage, Bracknell and Welwyn & Hatfield respectively, are all located within Britain's major high technology agglomeration, the Western

Crescent. Thirdly, the other entries cannot be so easily characterised by their spatial pattern because their geography is that of "dispersal". So, for example, East Kilbride (8), Glenrothes (18) and Greenock (20), are the representatives of Silicon Glen, but also listed are Macclesfield (10), already highlighted by Townsend's (1986) work, Newton Aycliffe (4), Islwyn (17) and Preston (25).

Thus, the geography of high technology can be summarised as heavily concentrated within the South East and, indeed, within certain counties and localities of the South East. But, in contradiction, outlying concentrations are to be found in a range of localities widely dispersed throughout Britain.

A sectoral geography of high technology industry

Spatial disaggregation has given greater insight into the geography of high technology but further disaggregation can take place to enhance the picture. For what must be remembered also is that "high technology industry" itself is an **aggregate term**. Chapter Two highlighted that the individual contents of the classification are a matter for debate but, nevertheless, it is a term which describes a **collection of industrial sectors**. Hence, further insight is to be gained from **sectoral disaggregation.**

Firstly, use of the aggregate term "high technology" disguises the fact that **individual high technology sectors are experiencing a variation in their fortunes**. Hall et al. (1987) found that between 1975-83

five of their high technology sectors experienced job decline ranging from 5.65% for pharmaceuticals (MLH 272) to a staggering 59% for broadcasting, receiving and sound equipment (MLH 365). In contrast, their remaining two sectors experienced job growth, with electronic computers (MLH 366) achieving a growth rate of 34%. Hence, electronic computers actually went from a position in 1975 of employing 11,600 less workers than broadcasting, receiving and sound equipment, to one of employing 35,600 more in 1983.

A further example of the variation in individual high technology sectors' fortunes would contrast aerospace with computer services. Aerospace experienced severe job loss during the late 70s and early 80s period of restructuring, a process common to UK manufacturing as a whole, whilst computer services (an industrial sector not officially recognised before 1980), has continued on a path of extraordinary job growth since 1981 (Howells,1987; Kelly and Keeble,1988).[19] Such simple differences in dynamics as growth and decline, crucial though they are, can be lost when looking at high technology as an aggregate. And such differences are crucial, for the second element that is also lost when mapping high technology employment is that such **individual sectors have distinct and different geographies**, spatial patterns of growth and decline, which may or may not coincide. Hence, it is the unique

[19] In fact, the aerospace industry is still undergoing restructuring. For example, see Fairhall's (1990) article "How the collapse of the Berlin Wall has left Westland helicopters up in the air" and Beavis et al. (1990), "BAe to close Preston and Kingston plants with the loss of 5000 jobs". On March 21st 1991, BAe announced a further 4,700 redundancies and Hawker Siddeley 4,000 job losses throughout its divisions (The Guardian 22.3.91)

geographies of sectoral growth and decline which construct the geography of "high technology" employment thus far described.

Several articles have moved to a more sectorally disaggregated analysis by the sub-division of "high technology" into the dichotomy of "high technology manufacturing" and "high technology services". Martin (1988b) has shown that, at the regional level, the South East dominated employment in both high technology manufacturing and high technology services. In 1984, 41.1% of high technology manufacturing jobs and 54.9% of R&D employment was to be found in the South East (op.cit.,p.225,Table 10.4).

Similarly, Begg and Cameron (1988), in their ranking of high technology urban areas, also sub-divided their rankings on the basis of manufacturing and service employment. Hence, the top three areas, Stevenage, Bracknell and Welwyn/Hatfield are seen to have attained their positions due to very high manufacturing location quotients (LQ = 550+, UK=100). Yet all three localities also have an over-representation of high technology services. The comparison could not be more stark than with that of the fourth placed locality, Newton Aycliffe. Its position is entirely due to the presence of high technology manufacturing (LQ = 589) with its high technology services location quotient of 3.1 placing it joint 157th (out of 162) in the services ranking. The fifth placed area of Chelmsford has a similar, though less dramatic, under-representation of high technology services (LQ = 45). In

contrast to such localities, Harlow (placed 11th) has a similar over-representation of both high technology manufacturing and services (LQ = 280 and 269 respectively).

So, disaggregation using the dichotomy of manufacturing and services can provide greater clarity, yet the further step to analysis by sector still needs to be taken. Such a step was taken by Hall et al. (1987) with illuminating results (see Table 3.4):

> "For instance, aerospace (MLH 383) is concentrated in a few counties, such as Avon, Lancashire, Hertfordshire and Derbyshire. Indeed, some 90% of Avon's high technology employment was in that single industry at 1981; in Derbyshire and Lancashire the figures were 88% and 77% respectively. **It may therefore be more accurate to call these predominantly aerospace centres...**" (op.cit.,p.35-38, my emphasis).

The importance of delineating these counties as aerospace centres rather than more generally areas of high technology has been proven by the years since 1981. Figure 3.2. (p.79) shows that Lancashire, Derbyshire and Avon have all experienced high technology job loss between 1981-84. Armed with the knowledge that aerospace has seen a period of major restructuring and job shedding and the (sectoral) geography of aerospace outlined in Table 3.4, it becomes clear that the major, if not **the**, component of high technology job loss in these areas is attributable to the aerospace industry. Indeed, Avon has continued to suffer with the announcement in March 1988 of over 1000 job losses

Table 3.4 Location quotients for counties for individual 'high technology' sectors.

Location quotient	MLH 272 pharmaceutical chemicals & preparations	MLH 363 telegraph & telephone apparatus	MLH 364 radio & electronic components	MLH 365 broadcast receiving & sound equipment	MLH 366 electronic computers	MLH 367 radio, radar & electronic capital goods	MLH 383 aerospace equipment manufacturing
8.0+				Mid Glamorgan Essex			
7.5–8.0					Berkshire		
7.0–7.5					Hertfordshire		
6.5–7.0		Fife region					Avon
6.0–6.5							
5.5–6.0							Isle of Wight Somerset
5.0–5.5	Nottinghamshire West Sussex						Hertfordshire Derbyshire Lancashire
4.5–5.0	Cheshire	Cleveland Nottinghamshire					Clwyd
4.0–4.5		West Midlands				West Sussex Fife region	
3.5–4.0	Hertfordshire	Merseyside	Fife region		Hampshire	Berkshire Lothians region Hertfordshire	
3.0–3.5			Essex	Hampshire		Essex Dorset	
2.5–3.0	Kent		Bedfordshire Mid Glamorgan		Staffordshire	Surrey	Gloucestershire
2.0–2.5	Merseyside		Wiltshire West Sussex			Kent Hampshire	Dorset Surrey

Note: Only location quotients above 2.0. Base = UK.

SOURCE: HALL et al., (1987), TABLE 3.9

at BAe's Bristol plant, whilst Lancashire has been devastated by the most recent decision of BAe to close its Preston plant with the loss of 3,000 jobs.

Table 3.4 similarly shows that the high technology agglomeration Silicon Glen is one predominantly based on the electronics industry rather than high technology in its widest sense. In particular, its fortunes have been dictated by radio, radar and electronic capital goods (MLH 367), a sector which experienced employment growth between 1975-81 when other high technology sectors were experiencing job loss. Most dramatically, Hall et al's (1987) analysis by sectoral geography did confirm that one county could truly be described as "the county of high technology industry". Berkshire experienced employment growth in all seven high technology sectors over the period 1975-83 (op.cit.p.46).

So, Hall et al. (1987) have shown the significant variation to be found in the geographies of individual high technology sectors. Similarly, Cooke (1986) has highlighted the sectoral specialisation of individual localities such that:

> "...each of the southern high-scoring localities with the exception of Slough is dominated by a particular four-digit SIC activity with both large employment numbers and very high location quotients." (op.cit.,p.24)

For example, Chelmsford, ranked fifth by Begg and Cameron

(1988), gained that position due to its sectoral concentration in radio and electronic capital goods (AH 3443) and, more precisely, the presence of GEC-Marconi in the locality. In contrast, Hertford and Harlow, although well represented in a range of high technology sectors both had a specific concentration in aerospace (AH 3640), principally due to the presence of BAe and Hawker Siddeley Aircraft (op.cit.,p.24).

The move to a sectoral analysis confirms that individual high technology sectors have their own distinct histories of (non) growth and unique geographies which may vary markedly to those of high technology as an aggregate. Indeed, disaggregation sectorally, as well as spatially, reveals a complex mosaic of localities experiencing unique combinations of high technology employment growth and decline. However, such a disaggregation does not alter the overall geographical pattern of high technology employment described. That is, a sectorally-based "high technology spatial division of labour" (Massey,1984) dominated by the South East.

3.3 The Uneven Spatial Development of Britain's High Technology Industry: The Nature of Jobs

The geography thus far portrayed depicts the uneven development of high technology in Britain today, but it does so through only one dimension. Only the **quantitative** aspect of this geography has been discussed thus far. Yet, as has been stressed, the **qualitative** dimension, the **nature** of the jobs as well as the **number**, must be

integrated to obtain the complete picture.

Chapter Two discussed this qualitative aspect of employment as a major problem concerning the SIC classification system, for jobs are not classified by their content but rather the product sector within which they take place. One example of such a SIC classified high technology sector, in which production functions can be reasonably easily delineated, is that of semiconductor production:

> "Semiconductor production involves five component labour processes. These are (a) research and development (R & D); (b) mask making...; (c) wafer fabrication...; (d) assembly of transistors, diodes and integrated circuits and (e) final testing of the product. These component labour processes have widely varying needs in terms of capital investment, labour skills, specialized inputs and so on. R & D, though capital intensive, also demands the application of highly qualified and creative scientists and engineers. Mask making and wafer fabrication are capital intensive also, and require highly skilled technical labour. However the latter is distinguished from the former by the fact that it requires, in addition, significant numbers of semi-skilled workers, particularly as operators of the 'diffusion' furnaces. Assembly has been predominantly a labour intensive process given over almost entirely to unskilled labour, although in recent years automation has begun to take place. Final testing, though increasingly capital intensive and requiring significant inputs of technical labour, also requires reasonable amounts of unskilled labour." (Henderson,1987,p.8)

Taking a purely quantitative dimension, all the jobs described above, whether R & D or assembly, are "high technology" by virtue of their constituting part of the production process of a high technology product, semiconductors. Yet, it is quite clear from Henderson's work that the technological content of each job (defined in terms of the social construct "skill") ranges from almost negligible to very high indeed. This point warns us, in the first instance, that the geography of high technology so far described must be treated cautiously for it is clear that not all the jobs in the count are high technology. But, this is merely a reiteration of an earlier point made in Chapter Two, where indeed the converse situation, of jobs of high technological content being excluded by virtue of their sectoral classification, was also raised.

Applying this point to the industrial geography already described can, however, involve an implicit assumption. That is, the assumption that jobs of varying technological content are spread throughout the country in equal proportion to the quantitative numbers to be found in each location. But, the unevenness of high technology has been continually emphasised and this particular instance is no exception. In fact, **the inclusion of the nature of jobs in the high technology equation serves to emphasise and deepen the picture of uneven development portrayed.**

The picture depicted has been one of a quantitatively dominant "South" (especially the South East) but with important concentrations of high technology industry to be

found throughout the remaining regions. The inclusion of the qualitative dimension, it will be seen, expands this picture by emphasising the qualitative, as well as the quantitative, **dominance** of the South East in the geography of high technology industry.

Earlier, reference was made to the work of Massey (1984) in which (corporate) "spatial structures of production" have been conceptualised and described. Morgan and Sayer (1986), taking her lead, have also described how corporate spatial structures of production can, at the aggregate level, create a **hierarchical spatial division of labour in which regions can be identified not by the number of jobs present but by the type of job present:**

> **"...different stages of production and parts of companies are separated out and located in the most appropriate places. Usually the control and conception ('top-end') functions of the company are restricted to the main metropolitan region while ('back-end') production is widely distributed. This functional differentiation is reflected in the occupational profiles of a given industry in different parts of the country or, for the multinational firms, in different countries. The proportion of unskilled and semi-skilled workers is much higher in peripheral regions than in central regions, and the converse is true for management and technicians." (Morgan and Sayer,1986,p.158)**

In essence, with the South East's dominance of the **sectoral** "high technology spatial division of labour" already portrayed, it will be shown that the region also dominates the **hierarchical** "spatial division of labour"

found within Britain's high technology industry today.

A depiction of this spatial division of labour has been put forward by Kelly and Keeble (1988) in their work on computer electronics in Britain (see Figure 3.5).

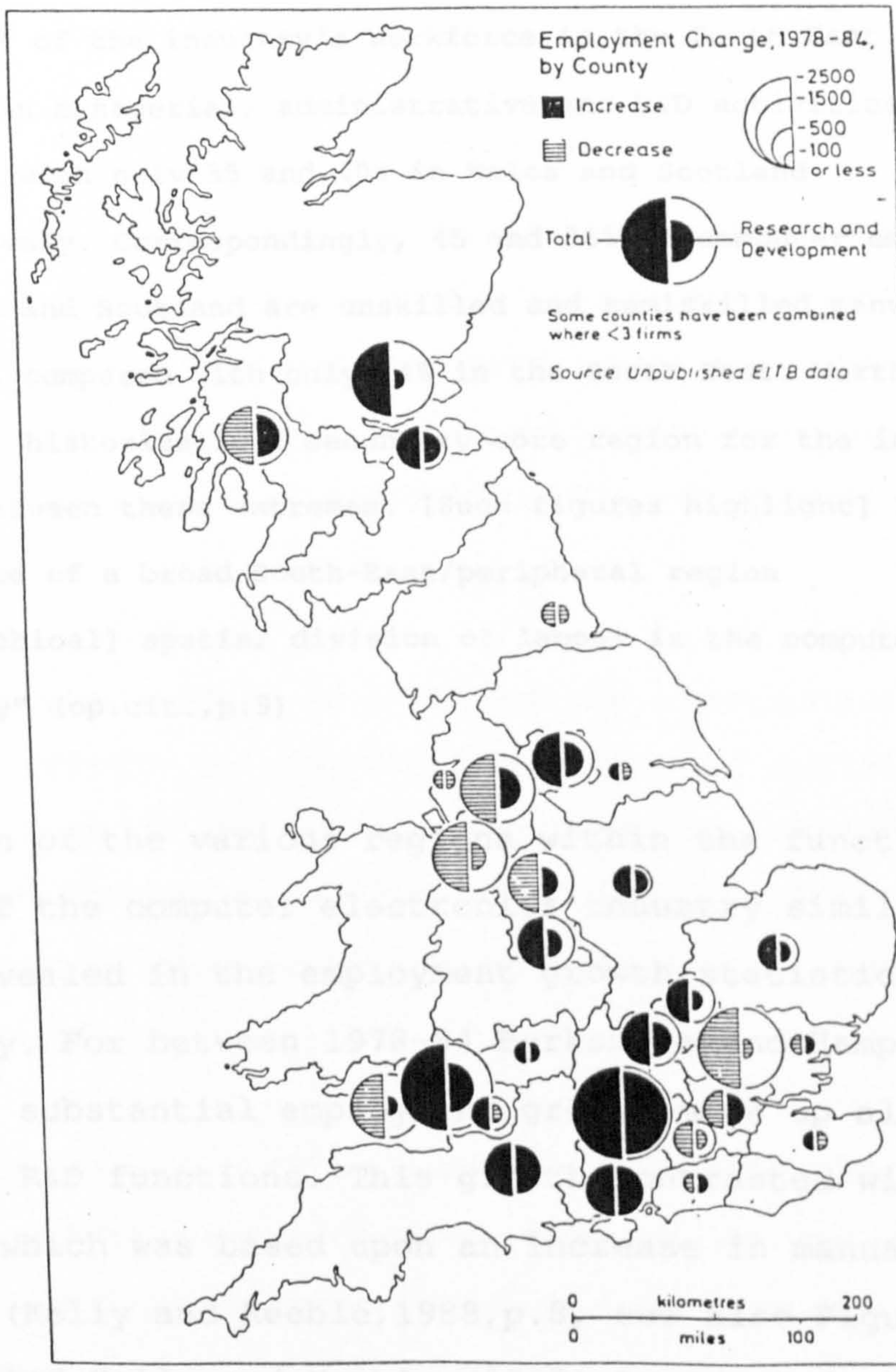

Fig. 3.5 *The geography of computer manufacturing employment change in Britain, 1978-1984.*
SOURCE: KELLY AND KEEBLE (1988), FIGURE 3

Firstly, in 1981, the South East dominated the **sectoral** spatial division of labour with 61.3% of computer manufacturing employment. The figure for computer software employment in 1984 was a similarly dominant 56%. This sectoral dominance was reinforced, however, by a dominance of the **hierarchical** spatial division of labour. Taking the occupational profile of the industry in 1984:

> "Some 64% of the industry's workforce in the South East is engaged in managerial, administrative and R&D activities, compared with only 35 and 40% in Wales and Scotland respectively. Correspondingly, 45 and 36% of computer employees in Wales and Scotland are unskilled and semiskilled manual workers, compared with only 14% in the South East. North West England, historically a secondary core region for the industry, falls between these extremes. [Such figures highlight] The existence of a broad South-East/peripheral region [hierarchical] spatial division of labour in the computer industry" (op.cit.,p.9)

The position of the various regions within the functional hierarchy of the computer electronics industry similarly has been revealed in the employment growth statistics for the industry. For between 1978-84 Berkshire and Hampshire experienced substantial employment growth made up almost entirely of R&D functions. This growth contrasted with that of Fife's, which was based upon an increase in manual operatives (Kelly and Keeble,1988,p.8, see also Figure 3.5). This led Kelly and Keeble (1988) to conclude that:

> "These examples suggest a growing polarisation in the 1980s in

> skill divisions...as between the South East core and the high-unemployment peripheral regions of Wales and Scotland." (op.cit.,p.8)

A final point to reiterate is that **this qualitative dimension to the uneven development of the industry reinforces the quantitative dimension of South East dominance already portrayed.** As can be seen from Figure 3.5, the South East may have an over representation of higher order functions but equally:

> "...the South-East's *absolute* dominance of production and employment nationally means that it also contains much the largest single concentration of unskilled manual workers (5200) in the industry, Scotland, the second largest, accounting for 3900 and Wales 2100..." (Kelly and Keeble,p.9,authors' emphasis)

Morgan and Sayer (1986), in studying the electronics industry in Britain as a whole, have depicted a similar spatial division of labour and described the location of three particular regions within this division. Firstly, the quantitative dominance of the South East in 1981 is shown by its share of:

> "...64.5 per cent of UK employment in electronic capital goods, 64 per cent in consumer electronics, 59 per cent in computers, 45.9 per cent in components, [and] 34.4 per cent in telecommunications..." (op.cit.,note 7,p.295)

They go on to describe the non-metropolitan South East

(represented for them by the M4 Corridor) in terms of its position as a privileged location for HQ's, public and private R&D facilities and national and international marketing functions. Hence:

> "What most distinguishes the M4 Corridor from Central Scotland or South Wales is its elite occupational structure and its dense decision-making network of activities..." (Morgan and Sayer,1986,p.166)

However, Morgan and Sayer (1986) go on to point out that although the core functions of the electronics industry are located predominantly in the South East and its M4 Corridor, this doesn't exclude other regions from such activities. Hence, they argue that Central Scotland (Silicon Glen) is not simply the "periphery" region it is often made out to be (see Kelly and Keeble above?). Routine production does play a major role while leading-edge R&D work is not present but, for example, US multinationals located in Scotland are engaged in development work to meet the particular requirements of the European market (see Dunford, forthcoming; Haug,1986 also). Similarly, Henderson (1987) has recounted the setting up of semiconductor wafer fabrication plants in Scotland by US multinationals. As was described above, this "middle-placed" aspect of the semiconductor production process involves highly skilled electronics engineers and technicians as well as "semi" and "unskilled" workers.[20]

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[20] Henderson (1987) also shows how through such foreign direct investment Silicon Glen has become inserted within an international spatial division of labour, whose core is to be found in Silicon Valley and periphery in such Third World locations as Latin America and Southeast Asia (see also Henderson and Scott,1988;

South Wales, in contrast, is viewed by Morgan and Sayer (1986) as acting almost exclusively as a "production platform" such that:

> "As a result South Wales has more of a 'headless' occupational structure than Scotland, with relatively low numbers of technically skilled and managerial employees." (op.cit.,p.170)

So, the inclusion of the qualitative dimension to employment serves to accentuate the pattern of privileged position of the South East in the uneven development of Britain's high technology industry. Moreover, it reveals the form of this uneven development to be not only due to the South East's numerical dominance of Britain's high technology employment but, also, to be combined with the South East's functional domination as the location for control and conception functions. The region is the pivotal focus of Britain's high technology spatial division of labour.

3.4 The Geography of High Technology: Uneven Processes of Development

The above pages have portrayed the distinctive geography of high technology industry in Britain today. It is a portrayal of a **pattern** of uneven spatial development from which the South East, and most particularly the Western Crescent, emphatically emerges as the winner. But, whilst the construction of such a pattern is of crucial importance as a first step of analysis (it provides the object of our

Sayer,1986)

explanation), the aim of the thesis is an attempt at explanation of (elements of) this pattern and hence, an attempt to understand the **processes** creating this pattern. Thus, within this context, the (uneven) industrial geography of high technology must also be read as the spatial consequences of the (uneven) **processes** of development endemic in the structure of capitalism itself (Morgan and Sayer,1988,p.19). In fact, for some, this geography represents the spatial expression of a **process of structural change** labelled "high technology":

> "The historical geography of high technology industry thus presents us with a new set of detailed contingent expressions of capitalist development" (Scott and Storper,1986,p.2)

Yet, exactly what process of structural change (development) is represented by high technology and, secondly, exactly how this process is working to shape the emergent form of uneven capitalist development described above is still unknown. Or rather it is yet to be discussed. For Chapter Two has already made clear that it is within theories of structural change that "high technology" attains its representation as a process of change. Hence, in the remainder of this chapter, three particular views of structural change, and the conceptualisations of "high technology" held within them, will be discussed. Moreover, this discussion will take place on the basis of how these views seek to explain the uneven spatial development of high technology industry.

3.5 Attempts at Explanation: Theories of Uneven Spatial Development

A first point to make is that the following three theoretical viewpoints which will be discussed, although difficult to combine, must not, however, be seen as mutually exclusive. Rather, each theory encompasses a particular emphasis in its explanation of structural change.

The "long wave" approach, which will be used to "set the scene", in particular emphasises the role of technological change, and has been criticised for so doing (Perez,1983; Marshall,1987). In contrast, the "flexible specialisation" thesis of Piore and Sabel (1984), in its attempts to avoid the "technological determinism" of long wave theory, has been accused of promoting an almost "behaviourist logic of structural change" which over-emphasises the transformative abilities of the individual (Amin and Robins,1989; Williams et al.,1987). The final viewpoint for discussion presents the collection of theories loosely classified under the "French Regulationist approach" (Aglietta,1979; Boyer,1986; Lipietz,1986; 1987). These theories encompass elements of both of the approaches already discussed, none more so than the theory of the New Industrial Spaces (Scott and Storper,1986; Scott,1988a; 1988b; Storper and Scott,1988).

<u>Long waves (Kondratiev cycles) of capitalist development: The transition to the 5th Kondratiev</u>

In 1925, a Russian economist, Nikolai Kondratiev (1925),

sought to identify the existence of long term cyclical movements in economic indicators of capitalist development. Such a phenomenon, previously sketched by the Dutchman van Gelderen (1913), involved a "long wave" of economic development, cyclical in nature and inherent in capitalist production, consisting of both an "upswing" and "downswing" phase. Fifty years on, this notion of economic cycles of approximately 50 years duration has experienced a widespread revival, with continued and inconclusive attempts to test statistically for their existence (see, for instance, Verspagen's [1989] report on the most recent long wave conference). At the same time, an alternative view to that of rigidly fixed statistical cycles has also taken shape. This view conceptualises long waves as historically distinct periods of economic development of between 40-60 years whose timing and characteristics are due to the combination of various complex factors of socio-economic life (Freeman et al.,1982; Mandel,1980; 1981; Marshall,1987; Perez,1983).

Causality? The importance of innovation

If the exact nature and actual existence of long waves is still the centre of much debate, so too is the likely cause of such cyclical patterns. Kondratiev's (1925) work was basically descriptive in nature and his nascent analysis of causality (based on investment patterns) unable to explain fully the transition from one long wave phase to another. However, if "waves" are to have any meaning it is crucial to be able to explain such transitions (Marshall,1987).

It was the thinking of Schumpeter (1939) which extended the groundwork of Kondratiev and put forward a possible causal mechanism to long waves. Accepting the existence of long waves, Schumpeter (1939) took the view outlined above that each wave was unique in its features and combination of specific socio-economic factors. But, he also proceeded to:

> "...analyse those features of the system's behaviour which could generate fluctuations irrespective of their specific and variable form. The most important of such features in his view was innovation, which, despite its great specific variety, he saw as the main engine of capitalist growth and the source of entrepreneurial profit." (Freeman,1982,p.208)

Schumpeter (1939) argued that entrepreneurs, in their constant search for profit, would innovate to create new profit possibilities. Further investment would then follow the initial innovation, through the actions of a "swarm" of imitators and improvers, so creating an economic boom. This "upswing" would not last, however, as competitive processes engendered by this new investment would erode profit margins over time. But this would, in turn, set the process to repeat itself as entrepreneurs continued to innovate in a renewed quest for profits. It was this sequence of events which, in Schumpeter's view, could create business cycles of varying length, including a cycle of the length envisaged by long wave theory.

Hence, Schumpeter's framework put forward a view of economic development based on new **technical innovation**. Economic development is a result of autonomous investment:

> "...a process of reallocation of resources between industries. That process necessarily leads to structural changes and disequilibrium if only because of the uneven rate of technical change between different industries. **Economic growth is not merely *accompanied* by fast growing new industries and the expansion of such industries; it primarily *depends* on that expansion.** However, it is not just a question of the rapid expansion of *new* branches of industry but also of the transformation of methods of production in the older branches too." (Freeman,1986,p.102,author's italics, my emphasis)

Hence, for Schumpeter and his followers, the process driving economic growth within the long waves is technical innovation, encompassed within new branches of industry. And, from a long wave approach, it is these new branches of industry which have subsequently been labelled as "high technology". It is the appearance and growth of high technology industries (representing a process of new technical innovation) which drives the upswing of an emergent long wave. However, it must be remembered that the particular industries high technology does represent is historically specific dependent on the long wave being discussed. In fact, usage of the label "high technology" has only become common in describing the new technological industries of the fourth and, particularly, the fifth Kondratiev waves.

Long wave theorists view the first Kondratiev wave as based on the newly mechanised industries of textiles and iron working. This wave gave way to a second based on the

arrival of the railways and the rise to ascendency of steam power. The most recent fourth Kondratiev entailed the post-war boom based on the spectacular growth of the major ("high") technologies and industries of electronics, synthetic materials, petro-chemicals and vehicles. But, once again, we are at a point of succession as the end of a decade of structural crisis heralds the end of the fourth Kondratiev and a move into the fifth wave based, it is suggested, on information technology. Within this wave the main "high technology" industries will be computers, electronic capital goods, telecommunications and software, with transformation of the economy occurring as the widespread diffusion of micro-electronics technology takes place (Freeman,1987,Table 15).[21]

The geography of innovation and the 5th Kondratiev

Thus, within (neo-)Schumpeterian long wave theory, "high technology" represents the structural process of technical innovation. But how, then, does the theory of long waves also represent a theory of uneven spatial development? The answer derives from the earlier recognition that uneven spatial development is the spatial portrayal of the uneven processes of development. Thus, the reasoning continues, it is the **spatial unevenness** of the process of innovation, the "geography of innovation", which has shaped the particular spatial impact of previous long waves and which

[21] It should be remembered, however, that Harris and McArthur (1985) have criticised the **faulty** use of the term "high technology" within long wave theory. They suggest this has led to the conflation of a variety of groups of technologies under the banner of "high technology" which, actually, can be distinguished through a more refined use of long wave theory (see Chapter Two,p.54).

is structuring the "geography of the 5th Kondratiev" (Goddard et al.,1986; Hall,1981; 1988; Oakey, Thwaites and Nash,1980; 1982):

> "Economic success lies with the country and the region and the city that can innovate." (Hall,1988,p.55)

And, concerning the fifth Kondratiev:

> "...tomorrow's industries are not going to be born in yesterday's regions...Britain's future, if it has one, is in that broad belt that runs from Oxford and Winchester through the Thames Valley and Milton Keynes to Cambridge." (Hall,1981,p.537)

Thus, the emergent "geography of the fifth Kondratiev" is indeed depicted in the geography of Britain's "high technology" industry.

But the question which then arises is why is the geography of innovation uneven. Why are some regions more innovative than others? It is at this point that the importance of the **socio-institutional** structure, within which technological innovation may or may not take place, is revealed. For Hall (1981) argues that the new innovative industries of the 5th Kondratiev are not to be found in the regions of previous growth (see above quote), because the socio-institutional structures of such regions are an inhibiting inheritance, if anything actually repellent, to the new industries of the emergent 5th Kondratiev.[22]

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[22] Interestingly, Gillespie and Thwaites (1988) have put forward an alternative

Rather, they are to be found within the regions of scientific research and scientifically-skilled labour.

Yet, and rather ironically, the critical importance of the socio-institutional structure in structuring (the spatial impacts of) the process of innovation within Schumpeterian long wave theory precisely highlights the most insistent criticism of the theory. Namely, that of the theory's **technological determinism** which ultimately diminishes the importance of the socio-institutional structure in technological change.

The criticism of technological determinism

Schumpeterian long wave theory, in putting forward the self-regulating economic mechanism of technical innovation as the causal mechanism of long waves, is argued to relegate the social and institutional features of the broader economic system to playing a passive role, being profoundly changed by innovation but essentially acting merely as the environment within which innovation takes place (Harris and McArthur,1985). Schumpeter (1937) argued for the importance of managerial and organizational innovations. Furthermore, the need for social and institutional conditions to emerge to facilitate the diffusion of new technology systems has also been stressed by Freeman et al. (1982). However, the social and

to such an interpretation. In their view as part of the economic "creative gale of destuction" experienced by such regions, a similar process will take place within the socio-institutional framework. Hence, rather than acting as a barrier to development such socio-institutional structures may well be a fertile area of new ground ready to be worked. The "Japanisation" of South Wales could be just such an example of this phenomenon.

institutional can be nothing but subordinate due to their exclusion from the causal mechanism (Perez,1983).

Perez (1983; 1985), acknowledging the technological determinism of Schumpeter, sets out in her own work to avoid this determinism by arguing that Kondratiev waves are not a purely economic phenomenon. She conceptualises the capitalist system as comprising two main subsystems which have different rates of change. On the one hand is the laggard socio-institutional system and, on the other, a technoeconomic system encompassing a "technological style". By this term she means an "ideal type" of production organisation or best "technological common sense". Kondratiev waves, and the upswings and downswings of which they are constituted, are simply the visible signs of the harmonious or disharmonious complementarity achieved between the dynamics of the two subsystems. Disharmony represents structural crisis in that the introduction of a new technological style is hampered by the slower rate of change in the laggard socio-institutional system, whose structure is still geared to the requirements of the previously dominant technological style:

> "The structural crisis thus brought about is then, not only a process of 'creative destruction' or 'abnormal liquidation' in the economic sphere, but also in the socio-institutional. In fact, the crisis forces the restructuring of the socio-institutional framework with innovations along the lines that are complementary to the newly attained technological style or best-practice frontier. The final form the structure will

> take...will however ultimately depend on the interests, actions, lucidity and relative strength of the social forces at play." (Perez,1983,p.360)

As Mahon (1987) writes, Perez's theorising continues Freeman et al's (1982) advancement of Schumpeter's original work. For further attention is brought to bear upon the ideological and organisational aspects of long waves and the process of innovation driving them, with the crucial question being asked as to which kind of institutional relations will be selected within which the process will take place. However, such a selection process reveals that Perez's work is still, ultimately, technologically deterministic.

For it must be stressed that social forces only come into play as they are **forced** to create a socio-institutional framework **complementary** to the new technological style (see quote above). Moreover, such complex social forces are seemingly able to create a complementary framework every fifty years or so. Essentially, Perez's work still represents a reductionist and technologically determinist view of "social forces". Social forces, although varied, act within the parameters of complementarity to the technological style. However, what Perez fails to recognise, as does neo-Schumpeterian long wave theory as a whole, is that **social forces themselves shape technology as well as being shaped by it.** They do more than provide a (conducive or not) environment for innovation.

So, neo-Schumpeterian long wave theory is criticised for the seemingly unproblematical structuring of the "social" and "institutional" to "fit-in" with the new technological style. In particular, the initial separation of the economic and social spheres is unacceptable to a further group of long wave theorists who are informed by a Marxist viewpoint. For example, the mere "enabling" restructuring of the social and institutional spheres is, in contrast, seen by these theorists as representing exogenous social and political forces which **determine** the length and character of long waves. Waves, in turn, are viewed not as internally regulated cycles but specific historical periods.

Marxist long wave theory

Mandel (1980;1981) combines the internally regulated economic cycles of Kondratiev with historical epochs of development seen as the outcome of external class struggle (Marshall,1987). He argues that the major causal factor in long waves is fluctuation in the average rate of profit.

Essentially, successive periods of "over-accumulation" by capitalists will lead to the tendency for the organic composition of capital to rise over time, so leading to the concurrent tendency for the rate of profit to fall. It is this internal mechanism for the tendency of the rate of profit to fall which explains the upper turning point within long waves. In other words, it explains the move from an expansionary phase to the "downswing" contraction phase. But, Mandel (1980) argues that there is no similar

internal economic mechanism to explain the lower turning point, there is no mechanism to trigger the move from depression into the "upswing". Rather, the trigger occurs through the intervention of exogenous social/political forces historically engaged in the class struggle. Particular "system shocks" allow a rise in the profit rate and the re-entry of the internal mechanisms of capitalism. Hence, Mandel has identified such exogenous triggers as the 1848 revolutions which broadened the capitalist world market or other historical defeats of the working class.

So, Mandel identifies the exogenous realm of the social and political as part of the mechanism of long waves but, just as Perez fails to explain the appearance of complementary socio-institutional innovations every 50 years or so, so Marshall (1987) criticises Mandel's view of class struggle. For the phenomenon of class struggle only appears at selective points in his approach, namely lower turning points, or approximately every 50 years.

The labour process approach

Yet Marshall argues that a fundamental contribution of Marxist theory, through writings on the "capitalist labour process", is the recognition of:

> "...the process of [continuous] technical change and capitalist development as a [continuous] *social* process involving the reproduction, not only of the physical or technical means of production, but also of the social relationships between capital and labour which accompany them." (op.cit., p.58,

author's emphasis)

Hence the social and political, like the economic and technical, are **endogenous** to the mechanism of capitalist development. And, as such, capitalist development can best be studied from a labour process approach, the labour process being the point of conjunction between the technical forces of production and the social relationships of production. Within such theory lies the ability:

> "...to relate the physical processes of technical and industrial change to the social structures within which these processes occur." (Marshall,1987,p.58)

Labour process theory views technology as merely one factor within the process of economic development and contextualises technological change within the wider social structures of which it is part. Indeed, it is the view of technology as independent of the wider social context which leads to the technological determinism of the neo-Schumpeterians (Marshall,1987). Although these theorists recognise that technical change and its effects are at least partially dependent upon catalytic social and political forces (eg. Freeman,1982; Hall,1981; Perez,1983; 1985), such theory has still been criticised for its failure to relate the **nature and form** of technology to the nature of wider social forces (Marshall,1987,p.11). In other words, to recognise that social forces shape technology and the path of technological change.

Marshall (1987) argues that technological change (including

the process of innovation) must be viewed as a (continuous) terrain of social struggle rather than merely a technical logic. Moreover, this recognition doesn't therefore exclude the discontinuous nature of technological change encapsulated in long wave theory but rather it allows Marshall (1987) to describe how:

> "...long waves unfold through historical processes of social change and conflict rather than in accordance with some pregiven pattern of technical change." (op.cit.,p.70)

For example, Marshall refers to the work of Benson and Lloyd (1983) who suggest that:

> "...it is not so much the discontinuous clustering of technical innovations stressed by the Schumpeterians which determines the pattern of long waves. Rather, it is the ebb and flow of class struggle over industrial organisation and technological change which both shapes and is shaped by the long waves."
> (Marshall,1987,p.68)

Long waves involve not only the periodic rejuvenation of capitalist accumulation but, by definition, the periodic transformation of the social relationships of such accumulation. The (negotiated) transformation of social relationships is part of the process of technical change and not merely a passive response to such change.
Thus, it is historical transformations of the labour process, rather than changes in technology *per se*, which represent the hub of the process of economic development (Marshall,1987,p.86). And, thus, long waves are typified by

their labour process forms - machinofacture, manufacture, Fordism etc. - rather than the leading technologies of the period a la a neo-Schumpeterian stance.

The 5th Kondratiev: Long wave of regional processes of development

This recognition of high technology as a contested process of social as well as technical innovation similarly implies a different interpretation of its spatial impacts from that of the neo-Schumpeterians. For:

> "...the pattern of regional development is not a predetermined outcome of technical advance or global economic forces. On the contrary it is a fluid process in which regional social and political forces are to some extent able to exert a relative autonomy in shaping their own destinies." (Marshall,1987,p.13)
>
> "...[This] is a perspective which identifies the role which uneven regional development plays in causing the long waves, rather than one which simply views regional differences as the outcome of pregiven global or abstract forces."
>
> (Marshall,1987,p.10)

Thus, Marshall (1987) criticises Hall's (1981) view of the geography of the 5th Kondratiev which:

> "...reinforces the notion that the social, economic and spatial effects of technological advance are predetermined and inevitable." (Marshall,1987,p.230)

In other words, Hall's (1981) reading of the spatial

impacts of Schumpeterian long wave theory reflects the major criticism of the theory itself in being technologically determinist.

In contrast, Marshall (1987) is arguing two critical points. Firstly, and as outlined above, that the course of technological development, including its spatial effects, is not predetermined but rather the result of social and political conflicts around technological change. Secondly, however, such conflicts have a distinctly regional aspect to their nature. There are distinct processes of regional development at play, taking different forms in different times and places but which are constitutive of long waves of economic development and not merely the outcome. This does not preclude viewing long waves of economic development as entailing changing spatial hierarchies headed by a succession of leading industrial regions but, rather, it allows for the recognition that:

> "The succession of leading industrial regions have provided the basis for regional social and political movements which have, at critical moments, contested and to varying degrees determined the ensuing course of national and sometimes international development." (Marshall,1987,p.228)

Thus, although disagreeing with Hall (1981) about how the spatial impact of the fifth Kondratiev is being determined, Marshall (1987) is in agreement with Hall about the pattern this impact is forming. With the move towards a fifth Kondratiev it is clear that new forms of spatial inequality are emergent and are depicted within the geography of

Britain's high technology industry. Indeed:

> "The high technology sectors have been in the forefront of this process of spatial change. The spatial distribution of the UK semiconductor industry is marked by the decentralisation of deskilled manual assembly work to peripheral industrial regions, contrasting with the concentration of a highly skilled technical elite in newly industrialising areas outside the old industrial centres." (Marshall,1987,p.233)[23]

Industrial divides: The transition to flexible specialisation

The concept of technological paradigms, as the central aspect of models of industrial development, is also to be found within the history of capitalist development put forward by Piore and Sabel (1984). Piore and Sabel theorise a "meta-history" of industrial development based upon a conceptual distinction between two types of production paradigm - mass production and flexible specialisation (craft production) [Williams et al.,1987].

As an organisational form, the most recent period of mass production is depicted as an industrial system based upon giant corporations which use product-specific machines, tended by semi-skilled workers, in a routinised production process geared to the production of standardised products (Piore and Sabel,1984,p.4). In contrast, flexible specialisation describes a production system, often led by

[23] In fact, this is less a new form of regional inequality than a replication of an existing form but by the new "high technology" industries (see Massey,1988).

networks of small and medium-sized firms, employing skilled craftworkers using new and sophisticated general-purpose (ie."flexible") machinery to provide a wide range of customised goods for large but constantly shifting markets (op.cit,p.5).

Taking this view of industrial history, Piore and Sabel (1984) argue that the current crisis in capitalist accumulation is due to the previously dominant mass production paradigm having reached its limits of expansion. In essence, we have reached "The Second Industrial Divide" where, once more, the choice of industrial development path is open to us. Whilst Piore and Sabel (1984) argue that a choice is still to be made between either a re-formulated mass production system (multinational Keynesianism) or flexible specialisation, for many that choice has seemingly been made with the re-emergence of flexible specialisation heralded as the pathway out of crisis (Cooke,1990; Hirst and Zeitlin,1989; Murray,1985; Sabel,1989; Scott,1988a).

A number of processes of change, among them the appearance of "flexible" technology, are together argued to be precipitating a general shift towards the development path of flexible specialisation.[24] And it is in the guise of

[24] As Piore and Sabel (1984) point out, however, whilst such technology, especially the new computer-based technology, is capable of producing enhanced "flexibility", it may do so to a variety of degrees and in a variety of environments. Care must be taken to avoid the "technologically determinist" view that such gains in flexibility are due solely to new technologies which are **inherently flexible**. Rather, advances in manufacturing flexibility gained from the introduction of new technology are also attributable to other factors, such as their introduction within competitive environments favouring flexibility (op.cit.,pp.258-263). Indeed, Sayer (1989b) has taken up this point to show how such "flexible" technology may equally be applied within mass production

the new flexible technologies that the concept of "high technology" is held within the flexible specialisation thesis. For the emergent historical form of this production system is personified by:

> "...the high-tech industries and the traditional dispersed conglomerations in machine tools, garments, footwear, textiles, and the like - all revitalised through the **fusion of traditional skills and high technology.**" (Piore and Sabel,1984,p.279, my emphasis)

Moreover, it is this structural shift to "flexible specialisation", built upon the "flexible/high" technologies, which is seen as holding major repercussions for the geographical organisation of production. For, embedded within Piore and Sabel's (1984) conceptualisations of systems of production, are conceptualisations of the spatial form which they take. In essence, such systems present more than a production logic; they also present a **territorial logic.**

Industrial districts and the renaissance of the regional economy

Thus, whilst the system of mass production has represented the giant (multi-national) corporation, structuring international space according to its internal organisation of production (see for example, Froebel et al.,1980) and expanding into new geographical markets in search of mass

(eg.Japanese flexible mass production) as show any bias towards the production system of flexible specialisation.

demand for its mass produced products, the territorial logic of flexible specialisation is placed at the opposite end of the spatial spectrum, within the "industrial district" (Piore and Sabel,1984; Sabel,1989).

The nineteenth-century's centres of flexible specialisation were to be found within such industrial districts as Birmingham and St. Etienne (producing guns and hardware), South East Lancashire (textiles) and Sheffield and Solingen (cutlery). In turn, with the move to centre stage once more of flexible specialisation, a new geography of production is emergent based on the "renaissance of regional economies" in the guise of a series of new or resurgent "industrial districts" of production (Sabel,1989,p.22). Central to this renaissance are the new "flexible/high" technologies leading to not only the "high technology industrial districts" of Silicon Valley and Route 128 but, also, the districts of "high technology cottage industries" to be found in regions throughout Western Europe but, most famously, within the "Third Italy" (Piore and Sabel,1984). Hence, it is on the basis of this re-emergent territorial logic of flexible specialisation, "the reconsolidation of the region as an integrated unit of production" (Sabel,1989,p.18), that the interpretation of Britain's changing geography of production, including the geography of high technology industry, may be made.

Unfortunately (?), it may only actually be within the geography of high technology that such an interpretation can be carried out, if at all. Take, for example, the edited collection by Hirst and Zeitlin (1989) entitled

"Reversing Industrial Decline". This represents an analysis of Britain's economic decline and possible future corrective industrial policy, principally written by exponents of the flexible specialisation thesis. Yet it is noticeable that within this book's covers, whilst listing a stream of newly formed or revitalised "industrial districts" from Denmark, France, Italy, Spain, Sweden and West Germany to the United States (Silicon Valley, Route 128, Los Angeles, Orange County) and Japan, Sabel (1989) does not produce a single example of such a district from Britain. Cooke (1990), too, is seemingly forced overseas (Italy, Spain and France) to find examples from which to draw lessons for UK local economic policy. Indeed, the UK literature seems less an exposure of examples of industrial districts within the UK, than an analysis of how local economic intervention may be shaped, by the flexible specialisation model, to revitalise our traditional industries (for example, see Best (1989) on the North London furniture industry and Zeitlin and Totterdill (1989) on the British clothing industry).

The geography of high technology may, however, hold out some hope for followers of the flexible specialisation thesis in the UK. Whilst the evidence is hardly conclusive, the "dispersed clusters" of high technology industry discussed earlier may possibly represent the first indications of the emergence of regionally-based industrial districts. Moreover, possible examples of high technology industrial districts exist within the literature. Hence, MacGregor et al. (1986) have charted the growth of high technology within the Newbury district (part of the Western

Crescent), although no attempt was made to identify a critical element of industrial districts, namely evidence of an "industrial community" (Piore and Sabel,1984). However, evidence of such a "community" has been provided in the case of high technology agglomeration in Cambridge(shire) where there are:

> "...highly-localised clusters of new high-technology firms which exhibit dynamic growth through a process of 'synergy' or intense interaction between new firms and entrepreneurs, research institutions, local banks and finance agencies, and business service organisations..." (Keeble and Kelly,1986,p.80 quoted in Keeble,1989,p.158)

The "Cambridge Phenomenon" (Segal et al.,1985) may well represent Britain's premier example of a (high technology) industrial district. It is also clear, depending on your definition of "region", that the South-East's regional economy is partially based upon and, has arguably been regenerated by, high technology industry.

<u>Regimes of accumulation: The transition to a post-Fordist era</u>

The concept of historical periods of hegemonic dominance by a particular production paradigm is also encapsulated in the work of theorists of the "French Regulation School" (Aglietta,1979; Lipietz,1980; 1986; 1987). However, the *technological model (or paradigm)* describes only one set of relationships within any hegemonic *model (or pattern) of development* (Leborgne and Lipietz,1988).

The *technological paradigm* describes the principles of organisation of the labour process (and not just the technology involved in the production process). Thus, during the recent "Fordist" model of development, such organisation was based on "Taylorist" principles, involving an extended technical division of labour and standardisation of duties, within a production process also characterised by its separation of conception and execution. Moreover, the combination of Taylorism with the new technology of transformation and, in particular, the new technology of transfer (Blackburn et al.,1985), created a system of production distinguished by the rise of "assembly-line" mass production (Leborgne and Lipietz,1988).

The *regime of accumulation* describes the second set of relationships within any pattern of development. These relationships involve the macroeconomic principle governing long run compatibility between levels of production and levels of consumption during any historical period of accumulation. The form of Fordist production organisation described above created significant gains (in their day) in both productivity and volumes of goods produced. Such growth in productivity translated into a growth in purchasing power of workers, to the extent that increased growth in production was thus counterbalanced by equally significant growth in consumption (Leborgne and Lipietz,1988).

The final set of relationships within a model of development concern the "regulation" of the articulation

between consumption and production. The *mode of regulation* consists of a set of institutions and social norms, procedures and habits to ensure the approximate unity of individual behaviour with the regime of accumulation (Lipietz,1986). Thus, for example, the creation of the welfare system during the period of Fordism in the UK is viewed as having acted to guarantee minimum levels of (mass) consumption whilst wider state intervention, such as in housing, smoothed the reproduction of labour.[25]

Just as the theories discussed above encapsulate the concept of a recent "phase change" so, within regulation theory, it is argued that the previously dominant pattern of development, labelled Fordism, is in crisis. We are in a period of structural crisis and change and again the role of new technology is critical in, if not actually determinant of, the outcome. For Leborgne and Lipietz (1988) argue that the crisis of Fordism is attributable to a crisis within the technological paradigm (representing the technology itself and the labour process within which it is structured). It is the (incipient) "knock-on" effects of this paradigm crisis within the wider sets of relationships of the Fordist regime of accumulation which

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[25] Just as (Schumpeterian) long wave theory has been criticised for its view of the socio-institutional structure as merely falling into complementary mode with the emergent technological paradigm, so the French Regulationists have similarly been criticised for their "functionalist" conception of the "mode of regulation":

> "However, we should not simply assume that the mode of regulation has the 'function' of making the regime of accumulation work...Rather, a regime of accumulation and forms of regulation get stabilized together, because they ensure the crisis-free reproduction of social relations over a certain period of time." (Lipietz,1986,p.20)

have, ultimately, been decisive in the regime's downfall.

However, possible ways out of this crisis have been opened up by the emergent paradigm of the "flexible" technologies and, once again, it is within this guise that the concept of "high technology" may be found. The restructuring role of the new "flexible/high" technologies is again a foundation stone of this theory of structural change. However, these technologies are not only viewed as revolutionising production but also, more explicitly, as new products in themselves and hence the basis for new industries:

> "This [modern electronics] industry is both a centrally symptomatic sector of the new regime and a general precondition of augmented production flexibility in the economy at large." (Scott,1988b,p.11)

Indeed:

> "The new industrial ensemble based on high technology industry that has recently moved to centre stage...has similarly seemed to usher in a new regime of accumulation and a corresponding mode of social regulation." (Scott and Storper,1986,p.2)

Yet, whilst the role of high technology in the new regime seems assured, much argument still reigns over the exact persona of the heir apparent to Fordism (see Chapter Four for further discussion). Whilst most, not all, ("regulationist") commentators do agree that its label may be that of "post-Fordism", a number of writers have gone

further by suggesting that the "post-Fordist" era may also be identified as a "new regime of flexible accumulation" (Cooke,1988; Harvey,1987; Martinelli and Schoenberger,1989; Schoenberger,1988; Scott and Storper,1986; Scott,1988a). Interestingly, the systems of "flexible production" emergent as part of the new regime include, but are not reducible to, elements of the system of "flexible specialisation" put forward by Piore and Sabel (1984). Flexible specialisation may be seen as only one of several alternative "flexible production" systems (Cooke,1988; Leborgne and Lipietz,1988; Lipietz,1989; Martinelli and Schoenberger,1989).

Furthermore, just as flexible specialisation is seen by Piore and Sabel (1984) as encapsulating a particular spatial form, so the move to flexible production is similarly viewed as encompassing a set of spatial imperatives. Hence, also, just as high technology industry is conceptualised as a carrier of these new flexible production systems, so the spatial structure of high technology is viewed as symptomatic of the emergent geography of post-Fordist flexible accumulation.

The geography of flexible accumulation

In recent years, several views of the likely configuration of the "geography of flexible accumulation" have been expressed (Cooke,1988; Martin,1988b; Martinelli and Schoenberger,1989; Schoenberger,1988; Scott,1988a; 1988b). At an international level it is argued that a "spatial levelling process" may be occurring (Cooke,1988). Cooke

(1988) has suggested that, within high technology, processes of international corporate networking, if not merger and acquisition, are extending the spatial spread of technological expertise. At the same time, this spatial spread is being both driven by, and grounded within, the growth of a series of international agglomerations, in what he has described as a "large agglomeration-economic effect" (op.cit.,p.295).

In similar vein, Schoenberger (1987;1988) has argued that the restructuring of production organisation with the move towards flexible accumulation is leading to "...a spatial reintegration of production within and across firms..." (Schoenberger,1988,p.258) such that the role of agglomeration economies is once again to the forefront. However:

> "...an element of footlooseness enters into the picture insofar as the question of where production will be reconcentrated - and agglomeration economies constructed..." (Schoenberger,1987,p.208)

That picture has, however, been most forthrightly drawn in the work of Scott and Storper (1986; Scott,1988a; 1988b). In their view, the "geography of flexible accumulation" can be characterised by the appearance of the **"New Industrial Spaces"**. These are a set of new or revitalised and re-emergent production agglomerations throughout Western Europe and North America, based upon the growth of the "new flexible industrial ensembles", and including the:

> "...high technology industries and their associated phalanxes of input suppliers and dependent subcontractors..." (Scott, 1988,p.175)

These New Industrial Spaces are, on the one hand, certain enclaves within older manufacturing regions. Examples include the film and printed circuit board industries of Los Angeles or suburban extensions of city regions, as in the case of the high technology agglomeration Route 128 (Massachusetts,USA). On the other hand are the "sunbelt area and third development zones". That is, areas previously peripheral or semi-peripheral to Fordist industrialisation. Such areas range from the widely quoted Third Italy, encapsulating industries such as shoes, ceramics and metal engineering, to high technology agglomerations ranging from Silicon Valley (Santa Clara County,USA) to the Scientific City (the region immediately south of Paris) to Britain's **M4 Corridor**[26] or Cambridge (Scott,1988a,pp.179-181). Thus, Britain's leading high technology regions also represent, in the eyes of Scott and Storper, leading regions of the emergent geography of flexible accumulation.

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[26] Scott (1988a) identifies the M4 Corridor as running from Reading to London although on what evidence is uncertain. I suggest, however, that the work of Hall et al. (1987) has, in fact, rendered this conception of high technology agglomeration in Britain incorrect. Rather, Hall et al.'s (1987) work highlights that whilst the Reading-London corridor does represent a concentration of high technology industry it is in fact part of a larger agglomeration labelled the **Western Crescent** (see Chapter Five also).

3.6 High Technology Industrial Spaces and Structural Change

So, this chapter has outlined the geography of high technology industry in Britain today, a geography of uneven development but at a variety of spatial scales. Clearly, the South-East dominates as the region of control, conception and execution. Yet intra-regional divides are also evident such that (strings of) individual counties, and even towns, within the South-East can be discerned as "cheek-by-jowl" winners and losers in the geography of high technology. Likewise, some winners may be found in other regions of Britain, in places like Silicon Glen, but, ultimately, many more losers may also be discerned. The chapter has then gone on to discuss the greater significance of this portrayal of uneven development. For it is, in part, a portrayal of the wider processes of structural change presently reworking the locational relations of industry. And thus, from contrasting points of view and most especially from within the New Industrial Spaces thesis, the geography of high technology is also viewed as symptomatic of a newly emergent form of capitalist uneven development. Whilst the exact processes of change driving this "paradigm shift" in the geography of production are disputed, there is one factor uniting the theories of uneven spatial development summarised above. That factor is the theorisation of a causal relationship between changes in the organisation of production and changes in the pattern of the spatial organisation of production. And it is within the following chapter that the particular logic of such a relationship will be scrutinised.

CHAPTER FOUR: Post-Fordist Industrial Location: A Theoretical Critique of the New Industrial Spaces thesis

4.1 Introduction

The previous chapter, having outlined the geography of high technology industry, turned in its latter stage to first attempts at gaining an understanding of this geography. In doing so, it turned to theories of structural change for explanation, for in seeking:

> "to explain 'where' you must be able to understand and explain 'why' and 'how'." (Massey and Meegan,1985,p.119)

And the 'why' and 'how' can only be understood by recognising that:

> "Locational behaviour must be viewed as ultimately the product of processes acting outside the spatial sphere itself, understood as the result of the combination of spatial and aspatial forces." (Massey and Meegan,1982,p.128)

Hence, it is through theories of structural change in the economy that explanation of the emergent "space-economy" of high technology industry is to be sought. Within such theory lies explanation as to how the present **period of economic restructuring is being translated into a period of spatial restructuring**. Yet, in taking such a position, we presuppose a fundamental recognition of the

existence of a **causal relationship between changes in the organisation of production and changes in the geography of production.** Indeed, the nature and form (eg. direction and necessity) of the relationship between processes of production organisation and spatial form has been central to longstanding and historical debate within (industrial) geography.

The different theories outlined in Chapter Three all encompass this relationship, in one form or another, between processes of change in the organisation of production, triggered and/or facilitated by "high technology", and changes in the pattern of spatial organisation of production. Indeed, within the New Industrial Spaces thesis, the high technology industries themselves are seen as symptomatic representatives of this relationship between process and pattern. Yet, at the same time, a lack of detailed conceptualisation and clarification of the actual causal process(es), "the logic", structuring the move from the non-spatial to the spatial realm is also evident within much of such theory. However, if we are to deepen our understanding of uneven development it is this causal logic which ultimately represents the "turnkey" of our understanding and it is this which is **the focus** of this research and the particular subject of this chapter. Moreover, it is the New Industrial Spaces thesis proposed by Scott and Storper which is the subject of this chapter. For, in advance of most theories of structural change and in answering the above criticism, it attempts explicitly to outline a logic which structures the move from the aspatial to the spatial.

4.2 The New Industrial Spaces[27]

As was outlined in the previous chapter, the starting point for the New Industrial Spaces thesis is the recognition of structural economic change, encapsulated for Scott and Storper by the transition to a new era of "flexible accumulation". This transition represents the move to a new historical form of "technological-institutional system of production" (Storper and Scott,1988; Scott,1988b).

Acknowledging the resemblance of such systems to "regimes of accumulation" as proposed in the work of the French Regulationist School (Aglietta,1979; Boyer,1986; Lipietz,1986; 1987), Scott and Storper view such systems as comprising four major elements: a set of production techniques; a characteristic form of organisation of production (inclusive of labour relations); a mechanism by which "surplus" is distributed and redeployed; and a process of aggregate demand (Scott,1988b,p.8). Through the history of industrial capitalism such elements have combined to create historically specific forms of technological-institutional systems, each system attaining a position of "domination" for some time as a more or less stable configuration, reinforced by a set of supportive social relations. In this context, the present period of structural change is viewed by Scott and Storper as the transition from the previously dominant "Fordist mass production" system to a new era dominated by a "post-

[27] Whilst the "skeleton" of the New Industrial Spaces thesis has been put forward in the joint work of Scott and Storper, in particular, it is the work of Scott which has "put flesh on the bones". Most especially, he has concentrated on the precise causal logic shaping the New Industrial Spaces and thus it is Scott's work which this chapter particularly focusses upon.

Fordist system of flexible production".

Flexible production and spatial agglomeration

The post-Fordist flexible production system is, it is argued by Scott and Storper, characterised by production techniques aimed at achieving rapid adjustability of products and production processes in response to highly contested, fragmented and unstable markets. Adjustability is achieved through enhanced flexibility of the technical and social relations of production. Evidence for this is the advanced extension of the social division of labour in the form of fragmented and specialised production units and/or labour relations and local labour markets increasingly organised around strategies of functional and numerical flexibility (Storper and Scott,1988). In the transition to the post-Fordist flexible production system:

> "...two interrelated new pathways to industrialization have recently begun to take shape. One of them involves a restructuring of Fordist mass production (in virtually all of the major consumer durables industries) through various combinations of automation, subcontracting and reconstruction of the employment relation to achieve more supple work rules and labour market practices. Another important pathway has been opened up by the rise of a series of new flexible industrial ensembles (i.e. collections of sectors) over the 1970s and 1980s." (Storper and Scott,1988,p.9)

Scott and Storper go on to identify these "new flexible industrial ensembles" as revitalized artisan production;

business services; and, as earlier suggested, high technology industry and its associated suppliers and subcontractors. Together, the appearance of these new ensembles and the restructuring of Fordist mass production are seen as accounting for the major part of present economic change, with the industrial pathway of flexible industrial ensembles viewed as particularly significant:

> "...because it accounts for a very rapidly increasing share of total employment and gross national product." (op. cit.,p.10)

Similarly, it is the emergence and **spatial agglomeration** of these new flexible industrial ensembles, represented by the "New Industrial Spaces" (such as those described in the previous chapter), which is of particular significance to Scott and Storper in characterising the emergent "geography of flexible accumulation" (Scott,1988a).

Hence, in summary, Scott and Storper outline the ways in which structural economic change (the move to flexible production) is precipitating the rise of a new form of industrialisation (flexible industrial ensembles) incorporating its own spatial dynamic (agglomeration) and geographical pattern of outcomes (the New Industrial Spaces). What is of particular interest here is, however, their explanation of the creation of this spatial dynamic.

The "spatial logic"[28]

Scott and Storper argue that the spatial logic of the New Industrial Spaces thesis can be traced from the fundamental dynamics of the capitalist process of production. These dynamics, it is suggested, revolve around the (technical and social) division of labour within production:

> "At the core of the industrial firm or plant is a set of labor processes...This notion is a crucial point of departure for any viable theory of the economic geography of production." (Scott, 1983a,p.235).

Moreover, and in keeping with the earlier point drawn from Massey and Meegan (1982):

> "...geographical developments and shifts relate to a very general system of dynamics within capitalist labour processes. These dynamics can only be comprehended as they themselves grow out of the (non-spatial) relations of production of capitalist society at large." (Henderson and Scott,1988,p.41).

The present transition from a Fordist to a flexible system of production entails a fundamental restructuring of the capitalist labour process. A restructuring of both the technical and social divisions of labour is creating new relationships both within, and particularly between, firms.

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[28] Of course, when using the term "spatial logic", that is not to imply that "space" itself inherently holds causal powers. Rather the term is used to refer to objects (with causal powers) which are necessarily located within space. The point is that whether an object's causal power is activated and with what effect depends on contingent conditions which are themselves dependent on spatial form (Sayer,1984,p.133; see also Sayer,1985a).

For Scott and Storper the importance of these changing sets of relationships is that they are creating spatial tendencies and, more particularly, the spatial tendency of agglomeration. The move to an era of flexible accumulation, in which the changing logic of production is increasingly predicated on "flexibility", represents a situation whereby:

> "...changes in economic conditions bring about intensified uncertainty and instability in production and increased competitiveness in final markets, internal economies of scale and scope within the firm begin to break down so that the entire production system is liable to display strong symptoms of horizontal and vertical disintegration. Such disintegration enormously enhances flexibility in the deployment of capital and labour for it permits producers to combine and recombine together in loose, rapidly shifting coalitions held together by external transaction linkages." (Scott,1988a,p.176).

Hence:

> "One of the basic common traits of the flexible production ensembles that have recently made their appearance in modern capitalism is their evident propensity to disintegrate into extended social divisions of labour, thus giving rise to many specialized subsectors. This process is a reflection of the tendency for internal economies to give way before a progressive externalization of the structure of production under conditions of rising flexibility, and it leads at once to a revival of proclivities to locational convergence

and reagglomeration." (op.cit.,p.176,my emphasis).

The key relation here is that an (aspatial) process of the "evident propensity to disintegrate into extended social divisions of labour" is causing a (spatial) process of "locational convergence and reagglomeration". This is the causal mechanism within the New Industrial Spaces spatial logic and it is founded upon Scott's incorporation of "transaction costs" into location theory (Scott,1983a; 1985; 1986a; 1988a; 1988b; 1989).

The "transaction costs" mechanism of the logic

Taking his theoretical foundations from Coase (1937), and incorporating the more recent continuation of this work by Williamson (1975, 1981, 1985) amongst others, Scott (1983a; 1988b) views the production system as a transactional structure. The individual firm represents a set of labour processes organised through a system of **internal transactions controlled by a managerial hierarchy.** In turn, each firm is organised into a production network through **external, market-governed transactions** with other firms. Hence, firms can be viewed as on a functional integration/disintegration continuum and:

> "...production consists of units of vertically integrated hierarchical order separated from one another *in a social division of labour.*" (Scott,1988b,p.25,author's emphasis)

More recently, with the empirical identification of "intermediate" organisational forms such as joint ventures

and strategic alliances (Cooke,1988; Chesnais,1988) and "quasi-vertical integration" (Leborgne and Lipietz,1988), Scott has commented on the irregularity of this continuum because of the lack of a "sharp break" between internal (hierarchical) linkages and external (market) linkages. In such cases transactions are governed by more complex "rules of order" including various kinds of power relations (1988b,p.24-5).

Fundamentally, however:

> "When internal transaction costs exceed external transaction costs labor processes are highly susceptible to *vertical disintegration*...By contrast, *vertical integration* tends to come about where internal transactions costs are lower than external transactions costs." (Scott,1986,p.220,author's emphasis)

Hence, any move towards integration or disintegration involves a corresponding change in the ratio of internal-to-external transactions.

Scott and Storper, in particular, have focussed on the widespread move to disintegration as part of the production logic of the new era. Moreover, they have argued that a spatial tendency of (re)agglomeration of production results from this process. Using transaction costs theory, they present a (necessary) logic linking transaction costs and location. The causal mechanism is situated within the conceptualisation of the firm as a network of internal and external linkages. For each (external?) linkage is

recognised intrinsically to possess a "spatial" cost. Whatever form the linkage may take, or whatever mode through which it is achieved:

> "...all inter-industrial linkages incur costs that are a positive function of linkage length." (Scott,1988b,p.31,my emphasis)

In other words, the greater the distance over which the linkage occurs, the greater the cost. Implicitly (or explicitly?) also, "external" linkages, by virtue of being off-site, are more "spatially dependent".

The transaction costs model implies that the process of "disintegration" involves a simultaneous process of "externalisation" as a greater number of external transactions are created. Thus, at this point, the essentially aspatial process of the (extension of the social) division of labour portrayed by Scott is transformed into a process incorporating a spatial tendency:

> "As the social division of labour moves forward [disintegration/externalisation], interestablishment transactional structures proliferate, and this immediately encourages certain kinds of costs to rise...The greater the spatial dispersion of producers, the more onerous these costs will be. The immediate consequence is that selected sets of producers with particularly elevated intragroup costs will tend to converge around their own geographical centre of gravity and thus to engender definite nodes of economic activity on the

landscape." (Scott,1988a,pp.176-7)

Simply put, the increased costs associated with increased external (as against internal) transactions will create a "spatial pull" whereby firms will tend to agglomerate to shorten the length, and hence the cost, of such external linkages. This, in Scott's view, is the key causal mechanism in the appearance of industrial agglomerations, particularly in todays post-Fordist times of the New Industrial Spaces, but also throughout industrial history.

However, a caveat must be added to this general conclusion concerning the spatial pull of interestablishment linkages. For Scott (1988b) suggests that:

> "....agglomeration is usually a response to a selected critical set of interestablishment linkages: not all (or even most) linkages of establishments in a given agglomeration will invariably be confined to the local area and...many establishments will also have connections on a wider national and even international scale."(op.cit.,p.32)

Indeed:

> "This critical range would seem especially to be made up of transactions-intensive (hence high cost) linkages involving above all flexible, rapidly-shifting, small-scale, and non-standard connections **between producers.**"(Scott,1989,p.26,my emphasis)

Again, external linkages may be viewed as more spatially

dependent than internal linkages but, in this case, on the basis of their nature. For external linkages are created precisely because of their highly "flexible" (but transaction-intensive and costly) nature. Moreover, it is precisely these sorts of flexible external linkages which are being created by producers in the transition to the new era of flexible production. Hence, also, the evidence of (re)agglomeration of production as part and parcel of this transition.

The "agglomeration" mechanism of the logic

The above mechanism is the key dynamic of the present spatial reagglomeration of production but further, and analytically linked to this dynamic, is a second mechanism Scott identifies which helps explain the continued "locational implosion" of these production agglomerations (Scott,1988a,p.178). That is, firms once (or already) located within the production agglomeration may also undergo a continued process of "externalisation" for just as:

> "...on the one side, the social division of labour provokes spatial agglomeration as a way of lowering external transaction costs; on the other side, agglomeration encourages further social division of labour and in-migration of new producers precisely because it lowers these costs..." (Scott,1988b,p.33)

So, disintegration causes agglomeration and agglomeration causes disintegration.

Finally, the agglomeration economies described above which arise endogenously out of the organisation of production itself, are further strengthened by better known and more "theoretically traditional" forms of agglomeration economy. Scott, in particular, highlights two of these economies. Firstly:

> "With the rise of any industrial agglomeration, local labour markets are set in motion, and they too help to boost processes of spatial concentration and growth." (Scott,1988b,p.33)

With the rise of "flexible" industrial agglomerations, new forms of "flexible" local labour markets are also coming into being. Particular elements of such local labour markets cited by Scott (1988b) are increased labour turnover processes (job gains and losses and job switching) and highly developed labour market search activities by both employers and employees in response to such high turnover (op.cit.,p.33-38). From an abstract economic analysis of these processes Scott suggests that:

> "... the flexibility of [such] local labour-market arrangements will tend to increase as a positive function of size [of labour market]. This also suggests, again, that flexibility in terms of production organization and flexibility in terms of employment relations will intersect with and reinforce one another in particular localities." (op.cit.,p.38)

So, Scott (1988a) concludes that:

> "There are therefore strong agglomeration economies in local

> labour markets, and these intersect with and underpin the basic agglomeration economies that arise out of the organizational structure of production." (op.cit.,p.177)[29]

A second form of "traditional" agglomeration economy can be derived from processes of community life and social reproduction, embedded as part of any particular community yet uniquely advantageous to the production system of that individual community. This aspect has been partly captured by Alfred Marshall (1920; 1932) in his description of industrial districts where "the secrets of industry are in the air" but Scott identifies other processes of social reproduction such as local educational establishments, with courses specifically geared to the needs of local production, and the role of the state, both central and local. Ultimately:

> "In any industrial locality, then, complex and socially useful patterns of socialization and community development tend to evolve, enlarging the entire stock of agglomeration economies, and thus, in many direct and indirect ways, helping to reduce the private costs of production." (Scott,1988b,p.40)

In conclusion, it is the transaction costs mechanism which provides, in Scott's eyes, the core of a causal logic of spatial agglomeration of production. Moreover, triggered by

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[29] Scott is therefore implying a causal spatial relation within the workings of flexible local labour markets in addition to the causal relation arising out of the organisational structure of production. The particular focus of this thesis is, however, the spatial logic of the latter relation although criticisms of this logic (see later) may similarly be applicable to the spatial logic implied within the workings of local labour markets.

the rise of the flexible industrial ensembles, it is this explanatory mechanism which has come to the fore in the face of an emergent geography of flexible accumulation seemingly best characterised by its constituent agglomerations of production. However, this is not the end of the story. For although the logic of agglomeration has been explained there still remains the question of where such dynamic agglomeration is occurring today and why in particular regions and not others.

The geography of agglomeration (or flexible accumulation)

For Scott (and Storper), the emergent geography of flexible accumulation may be termed the geography of the "New Industrial Spaces" (Scott,1988a,p.171). Their work explains how:

> "On the one hand, processes of vertical disintegration and interlinkage induce spatial agglomeration at particular sites which then also become foci of intricate local labour market and community processes. On the other hand, there would also seem to be a tendency for these sites to swarm within extensive spaces or regions offering broadly positive sociocultural conditions for production." (Scott,1988b,p.41)

Accordingly, such regions most typically represent:

> "...kinds of locational environments uncontaminated by previous historical experience of large-scale manufacturing activity and Fordist employment relations...In such environments new and experimental kinds of sociotechnical structures of production

> can be established [ie.flexible production] with minimum local obstruction. This is doubly important where both avoidance of rigidity and the institutionalization of flexibility are primary goals." (Scott,1988a,p.178)

The New Industrial Spaces, as suggested earlier, are, at first sight, a group of disparate regions including inner city areas in large metropolitan regions; suburban extensions of such metropolitan regions; new "sunbelt areas" of high technology industrial development whether isolated urban sites or suburban technopoles; or large tracts of "semi-rural" Western Europe whose economies were often traditionally based on agriculture, trade and small-scale industry (Scott,1988a,p.179). However, what allows the grouping of such diverse regions, and acts as the definitive characteristic of the New Industrial Spaces, is precisely the structural dynamic of flexible industrialisation and reagglomeration of production evidenced by such regions:

> ".... each of these areas represents a unique configuration of social and political life, which means that each is also caught up in a unique developmental trajectory. That said, a common underlying system of structural dynamics can be detected in virtually every case. These dynamics, as we know, revolve for the most part around the social division of labour, the formation of external economies, the dissolution of labour market rigidities, and the reagglomeration of production." (Scott,1988a,p.181)

Concluding remarks

In summary, it can be seen that the New Industrial Spaces thesis in many ways represents the continued advancement of locational theory. Initially it identifies and brings together the growing empirical literature on regions representative of "the anatomy of job creation", not only in the UK but throughout the advanced Western economies. However, the thesis goes much further in its aims by attempting to theorise and explain the growth dynamics of these seemingly disparate regions.

Firstly, the thesis rightly "downplays" the explanation of regional growth based on the simplistic ahistorical listing of location factors, often including unique anecdotes, and often only applicable to the development of particular "spaces". In contrast, the evolutionary spatial dynamics of such growth regions are theorised as a response to the new imperatives of production introduced as part of the structural transition to a system of flexible production. Hence, the thesis acknowledges that "locational behaviour must be viewed as ultimately the product of processes acting outside the spatial sphere itself" (cf.p135).

With this critical aspect recognised, the New Industrial Spaces thesis explicitly attempts an explanation of its consequence; namely, that the translation of aspatial processes of change into geographical outcome must involve a causal ("spatial") logic. Furthermore, that explanation, in recognition of the charges of "determinism" levelled at previous causal relationships entailed in structural

theories of spatial change (see Chapter Three) allows for, on the one hand, the identification of a spatial tendency associated with structural change while, on the other, acknowledging the role of "contingency" in that the realisation of such a tendency will be:

> "...in practice greatly modified by the idiosyncrasies of local history and geography."(Scott,1989,p.32)

It is in the context of such an ambitious, forthright and far-reaching project, both theoretically and empirically, that the New Industrial Spaces thesis has been held up to the "critical light".

4.3 The New Industrial Spaces Thesis: A Theoretical Critique

A growing critique is now apparent, both specifically of the New Industrial Spaces thesis itself (Amin and Robins, 1989; Lovering,1990a; Martinelli and Schoenberger,1989) and, more widely, of some of the concepts "borrowed" and used within the thesis (Amin and Robins,1990; Gertler,1988; Pollert,1988; Rustin,1989; Sayer,1989b; Williams et al, 1987).

As already suggested, the particular interest of this study is the "spatial logic" of the New Industrial Spaces thesis and a critique will be put forward concentrating on three major research processes behind the creation of this logic: its conceptualisation; the empirical evidence for such a logic; and the methodology used in the collection of such

evidence. In addition, however, elements of a critique applicable to the theory as a whole will also be sketched.

The transition to a post-Fordist era of flexible production

The most fundamental of debates encompassed by the New Industrial Spaces thesis is that it, like many of its contemporaries (eg. Lash and Urry,1987; Leborgne and Lipietz,1988; Lipietz,1986; Piore and Sabel,1984), incorporates the suggestion that the advanced capitalist economies have made the transition to a qualitatively different period of capitalist accumulation. Indeed, more specific to the New Industrial Spaces thesis is its description of this transition as a movement from the Fordist era of production to the post-Fordist era and, moreover, a transition to a particular form of the post-Fordist era, namely an era of "flexible production and accumulation".

Firstly, argument still abounds as to the form and extent of any transition from Fordism to post-Fordism and, secondly, such argument is heightened by the implication that the form of any new post-Fordist era is already recognisable and, as such, may be labelled as an "era of flexible production and accumulation".

A transition...?

Taking the first aspect, what must be recognised at this point is the essential theory building process which has

taken place in constructing an argument for transition. Namely, the abstraction of structural processes from empirical "reality". At its most fundamental, it is this "reading" of the empirical which is at the heart of the present debates concerning the theorised notion of a structural transition. As Gertler (1988) wrote in his recent overview of some of the alternative "readings":

> "Each argument relies upon its own particular understanding of industrial history. Indeed, the very existence of these alternatives reminds us that this debate over 'flexible accumulation' and its constituent elements is really a historiographic one at heart: that, just as the adoption of flexible technology is not unproblematic, neither is the interpretation of its history self-evident (Mink, 1987)."
>
> (op.cit.,p.428)

Similarly, Amin and Robins (1989) highlight a variety of possible alternative "readings" within their work, and suggest that the specific "reading" adopted within the New Industrial Spaces thesis is an:

> "...extremely simplistic and contentious understanding of historical change."(op.cit,p.2)

Sayer (1989b) summarises the criticism being made by suggesting that the view of industrial history adopted by the New Industrial Spaces thesis is based upon a conceptualisation of capitalist industrialisation which, at its most extreme, is nothing more than a simple polemical contrast in the form of a "binary history". This history is

reliant upon the contrast between a (now recognised as) "rigid" Fordist system of mass production which has been superceded by a post-Fordist production system whose guiding principle is "flexibility". Opponents of this historical schema question the theoretical assumptions of, and the empirical basis for, its central concepts of "Fordism" and "post-Fordism".

Sayer (1989b) argues that the starting point of the schema is the ability to define "Fordism" satisfactorily yet:

> "The sense and reference of this term is itself extraordinarily loose, particularly when used to denote a major epoch of capitalist industrialization...Thus the current debate has not even got the easier side of its binary opposition firmly anchored." (op.cit.,p.667)

With such "looseness", problems are apparent such as:

> "...1) assuming mass production to be synonymous with inflexibility, period;...and 2) assuming that mass production and flexible production are alternatives." (Sayer,1989b,p.672)

Others have particularly questioned the empirical evidence for such theoretical concepts. Williams et al.(1987) in a strong critique of this "binary history" argue that empirically:

> "...mass production and flexible specialisation [a particular form of flexible production?] cannot be satisfactorily identified in particular instances, even at the enterprise and

> industry level." (op.cit.,p.417)

Similarly, Pollert (1988), whilst seemingly able to differentiate between production systems, does conclude that:

> "Types of technology, their organisation into different systems of production, and types of labour processes cannot be conflated into a single paradigm; the empirical evidence is far more complex." (op.cit.,p.57)

Hence, the argument runs, even at the height of "Fordism" empirical evidence suggests that "mass production" was never a generalised phenomenon but rather a system limited to a particular set of industries. Concomitantly, the much heralded "new" techniques of flexible production were also evident in a variety of other industries during Fordist times. Within the context of such empirical evidence, Pollert (1988), amongst others, has posed the question what is therefore "new" about flexibility and therefore "new" about the present period of production.[30]

Such seemingly contradictory empirical evidence has also led others to analyse the mental processes of "reading" which have taken place in the creation of such industrial histories. Hence, Bonefeld (1987) has argued that an

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[30] Interestingly, Pollert (1988) has gone on to answer this question herself. She views the celebration of "flexibility" as little more than an attempt to create, on capital's terms, a new ideology which accepts as inevitable the many disadvantages as well as advantages for labour associated with flexible production. In essence, she highlights the ambiguity of the term by asking the question "flexibility for whom?" which in her eyes reveals, amongst other aspects, the gender-blind nature of the term (see also Jenson,1989).

element of tautological thinking in such readings can be recognised in that:

> "...first of all a model or norm is abstracted from disparate historical tendencies, and then it is in the light of this model that the significance of these same tendencies is assessed." (op.cit.,p.124,quoted in Amin and Robins 1989)

In essence, the Fordist period has been characterised as, and reduced to, a period of mass production. Yet, increasingly, signs of a tendency towards a new production system based on flexibility have been identified, absolutised as the dominant trend and projected forward as the "stable end-state" for the new historical phase of capitalism. It is then in the light of such an "end-state" model that those same tendencies can be evaluated and, unsurprisingly, identified as significant (Amin and Robins,1989).

Ironically, the response to these criticisms can also be seen, in one sense, to rest upon the case that the critics have themselves used "selected readings" to create caricatures of the original texts. Whilst extreme conceptualisations of industrial history could be argued to rely heavily upon polemic, rather than empirical reality, other less virulent conceptual strains may not be so easily dismissed. For example, it is argued that the conceptualisation of Fordism held within the New Industrial Spaces thesis does not merely represent a particular production technique but rather a cohesive ensemble of social, political and economic features (ie. a

"technological-institutional structure of production and accumulation"). Hence, what characterised Fordist times was the qualitative "dominance" or "hegemonic" position of these features, of which the mass production paradigm was a part, and not the quantitative position per se of mass production (Schoenberger,1989).[31]

Therefore, the "quantity" of mass production is not the defining criterion and so, for example, it is wrong to suggest that the existence of flexible production in Fordist times highlights the reductionist theorising which has occurred and, more fundamentally, questions just what is "new" about flexibility. As Schoenberger (1989) writes:

> "...the fact that the [flexible production] practices identified as new can be shown to have a history does not rule out the possibility that their weight and meaning is different in the current context." (op.cit.,p.105)

Indeed, the precise point is that the weight and meaning of these practices has been re-interpreted such that these practices are now acknowledged by some commentators as **the restructuring force** of contemporary industrial change and, ultimately, the guiding principle of a new capitalist era. In other words, it is precisely that these practices are now, themselves, moving to a qualitative (and possibly quantitative) position of "dominance". Hence, as Gertler

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[31] However, exactly how you characterise "dominance" is also problematic. For example, is it simply a generally recognised "best practice" within production or possibly that production form prevalent in the propulsive sectors of the economy? (see Scott and Storper,1986; Storper and Scott,1988; for some attempts at characterisation).

(1989)concludes:

> "The principal debate now appears to rest not only upon the pervasiveness of flexible production, but also its significance within contemporary capitalist economies, no matter how prevalent it may be." (op.cit.,p.109)

...to flexible production?

However, if the principal debate creates a distinction between those questioning or advocating "flexible production practices" as the exemplars of a qualitatively new period of accumulation, a second related disagreement is also evident amongst the advocates themselves as to exactly what these exemplary practices actually are. So, whilst some commentators argue over whether or not a particular instance is indicative of the move to a new system or merely adaptation of the existing system, others argue that the shift has already been made but such an instance is by no means all-encompassing or, indeed, definitive of the new era!

For example, Lipietz (1989) whilst agreeing with the basic argument that a post-Fordist era is emergent, suggests that any attempt to identify the emergent era as that of an era of flexible accumulation is both premature and deterministic. The outlines of the new production era have yet to materialise fully and, more importantly, have yet to stabilise. New forms of production are in the ascendency but flexible production must be viewed as only one of several pathways. Rustin (1989) similarly argues against

equating one element of contemporary change with the whole:

> "Since socio-technical systems do not develop completely autonomously, but only in response to cultural definition, conflicts of social forces, and political decision, it is dubious in principle and possibly misleading in fact to make linear extrapolations from what might seem to be 'leading instances', or current trends, to the shape of the whole system." (op.cit.,p.62)

Hence, the New Industrial Spaces thesis, with its foundation upon the theorised move to a post-Fordist system of flexible accumulation, encompasses, for many, a:

> **"...highly selective and singular interpretation of structural change"** (Amin and Robins,1989,p28, my emphasis)

The evidence for, and problems of, such a selective interpretation become clear when discussing the repercussions of the shift to flexible production concerning the dynamics of industrial organisation and the division of labour within production.

<u>Organisational change: "Externalisation", "disintegration" and "the extension of the social division of labour".</u>

If we are focussing upon the "spatial logic" of the New Industrial Spaces, it is clear that the significance of the new flexible production ensembles does not purely stem from:

> "...their appearance in modern capitalism [but rather it] is their evident propensity to disintegrate into extended social divisions of labour". (cf. p.141)

For Scott and Storper it is the particular form of production organisation forwarded by the move to flexible production which has acted as the catalyst of the reagglomeration of production. It is the proliferation of external linkages as a result of the concomitant organisational processes of "externalisation", "disintegration" and "extension of the social division of labour", which they see as triggering the transaction costs mechanism and so creating the spatial tendency of agglomeration.

However, if one accepts the structural shift to flexible production, it will be argued that, firstly, the organisational response of "externalisation" of production instigated by this transition and, secondly, the subsequently derived processes of "disintegration" and the "extension of the social division of labour" do not represent an adequate account of all the possibilities for organisational change arising from such structural change.

An interpretation of which organisational responses occur (and are possible) derives from the model of the firm within the New Industrial Spaces thesis. Subsequently, it will be argued that the inadequate organisational responses allowed for within the thesis stem from flaws to be found

within the "transaction costs" model of the firm.

The firm is viewed as a set of production functions owned and organised through a set of internal linkages governed by managerial hierarchy. In turn, external market-governed linkages are held with other companies. Using this model of the firm, if a company takes over a function so that it becomes part of its internal network of production this represents the processes of "internalisation", "integration" and the "extension of the technical division of labour". Such organisational change has, in turn, been viewed as the characteristic organisational tendency during the previous Fordist period of production.

In comparison, when a firm "divests" itself of a production function which it then subsequently buys in through external market-governed linkages this is viewed as representing the processes of "externalisation", "disintegration" and "extension of the social division of labour". Within the New Industrial Spaces thesis it is argued that this is precisely the dominant organisational change which is taking place with the move to an era of flexible production and accumulation. The "uncertain" environment for production is breaking down internal economies of scale within the firm, hence the organisational response of "externalisation" (cf. p.141-2).

The firm as a social organisation

However, Lovering (1990a) argues that this chain of events,

whilst being "plausible" on the basis of certain documented instances, is stretched to become a "descriptive generalisation" within the New Industrial Spaces thesis. For he argues that:

> "Scott's theory assumes that uncertainty is <u>necessarily</u> translated into declining internal economies of scale [and hence externalisation]. But this assumption is not justifiable." (Lovering,1990a,p.7,author's emphasis)

In reality, the translation of such "uncertainty" can lead to rising or declining internal economies but the point is that such translation is dependent upon:

> "...the context of a range of economic practices and institutions. Scott's model of the firm under flexible accumulation presupposes a *particular* conception of economic uncertainty and firm decision making.
> In the real world the translation from economic uncertainty to firm behaviour is a social achievement, reflecting the political economy of a specific society." (op.cit,p.8,author's emphasis; see also Gordon,1989,p.27)

In the world of the New Industrial Spaces, however, translation is based upon a (ahistoric) model of the firm as a "node of market exchange".

> "This conceptualisation strictly limits the possibilities for an analysis of the firm as a social organisation in a specific historical context." (Lovering,1990a,pp.9-10)

The transaction costs model of the firm represents a "pure theory of exchange" (Thrift,1990). Organisational dynamics are studied through a comparison of marginal costs in which the organisation (hierarchy) is only viewed as a response to market failure. Thus, as highlighted by Foray (1990):

> "...the transactional approach requires us to adopt an essential hypothesis (and which in a marginalist perspective is self-evident) relating to the perfect substitutability of internal and external kinds of resources or activities." (op.cit.,p.6)

Yet this does not satisfactorily represent the empirical realities of production. Such reality highlights that the integration of a resource into a firm tends to make this resource more and more specific in that, through the process of integration, it acquires new qualities specific to the socio-economic context. In addition, a learning process within the firm begins through the self-same process of integration. Hence, this recognition of "asset specificity" calls into question the assumptions of perfect substitutability and transferability in the model and highlights that transaction costs only account for the negative side of any exchange, namely "the economics of friction" (Foray,1990).

Moreover, the motor of organizational change for the firm must thus be viewed as the reduction of "exchange transaction costs". To apply such cost-based analysis empirically is fraught with difficulty and rarely achievable (Gordon,1989,p.26-7; Sayer,1989b) but,

furthermore, and to return to the realities of production:

> "Cost-benefit analysis of procurement isolates only one element of a firm's structure of transactions... Reduction of all firm decision-making about the internalization or externalization of activities to cost calculations alone ignores technological, informational and social interdependencies within the production process that promote integration of activities regardless of relative cost curves (Walker,1988). The "social embeddedness" (Granovetter,1985) of both firms and markets is ignored." (Gordon,1989,p.25)

In essence, the model reduces the firm to an exchange mechanism and not a mechanism for production. As Sayer (1989b) suggests:

> "If firms are to survive and not merely minimize costs at a point in time they need to protect and develop the routines and knowledge on which their future depends (Hodgson,1988), and this dynamic, evolutionary aspect of industrial organisation also needs to be considered in explaining vertical disintegration. Arguably this is a major factor in restraining firms' use of outsourcing and hence inhibiting vertical disintegration, even where short-term cost alternatives would suggest it..." (Sayer,1989b,p.680)

Ironically, this point is no more relevant than when dealing with the dynamics of production within "high technology" industry. For, as Foray (1990) argues, the transactions view of production:

"...requires a universe of technological tranquility, in which techniques are definitively constituted and known, [and] the firm has no need to transform its organization (specification of resources, learning) in order to exploit them or respond to new productive problems. Here, the minimization of coordination costs can be considered as the motor of organizational dynamics" (op.cit.,p.7,my emphasis)

Such a situation could not be more removed from the reality of production for high technology industry where the name of the game is often stated as "innovate or die". Linkages as relations of exchange are important for their **actual content rather than their cost per se** and, anyway, the ability to cost production functions is severely hampered by the uncertainty of knowledge as to just what those functions will actually entail (Gordon,1989,pp.25-27).

The "transaction costs" model of the firm fails to conceptualise the firm as an organisation driven by a **variety** of "goals" derived from the act of **doing production** (eg capital-labour relation). The translation of the "economic uncertainty" of flexible times into firm behaviour characterised by "externalisation" may not be assumed. It may therefore also not be assumed that the "transaction cost" spatial mechanism of agglomeration will be triggered as a result of such behaviour.

The "process chain"

Secondly, if "externalisation" is accepted as <u>the</u>

organisational response, the model also implies the processes of "disintegration" and "extension of the social division of labour". The occurrence of these simultaneous processes, as we know, is critical in triggering the spatial mechanism of the New Industrial Spaces thesis. **However, other increasingly apparent flaws within the transaction costs model of the firm reveal these simultaneous processes to be a "chain of events" and, moreover, a process chain in which one process is not the necessary precondition of another.**

Sayer (1989b) discusses how there are, in fact, two separately identifiable criteria used in defining the boundary of the firm in the above model. On the one hand, the criterion of "ownership" and, on the other, the criterion of "market or hierarchically-governed linkages". A problem has arisen because the model presupposes that "ownership" corresponds with "hierarchically-governed linkages" (the internal aspect of the firm representing the technical division of labour) and "non-ownership" corresponds with "market-governed linkages" (the external aspect of the firm and the social division of labour). However, "the scope for noncorrespondence" of the two criteria has expanded in modern industrial times (Sayer,1989b) and so, therefore, has the "scope for noncorrespondence" within the "process-chains" of organisational change.

This is particularly evident concerning a form of organisational change, an "externalisation" process, which

has been explicitly associated with the move to an era of flexible accumulation. Cooke (1988) and Martinelli and Schoenberger (1989) have highlighted a significant acceleration in the rate of formation of strategic alliances, joint ventures, consortia etc., between (particularly high technology) firms under the conditions of flexible production. The point is, however, that whilst these organisational forms represent **external** linkages between companies, they are **not "market-governed"** (Cooke,1988; Gordon,1989; forthcoming). Similarly, whilst such organisational forms may be viewed as an avenue by which a firm can possibly "internalise" a particular function, such as R&D or marketing, the extent of ownership of this function may range from "joint" to effectively none.

Hence, using *the* model of the firm outlined above, these organisational forms represent *neither integration* nor disintegration. In fact, Cooke (1988) has gone on to describe these forms of industrial organisation, based on external linkages, as representing the process of "diagonal integration", whilst others prefer to use the term "vertical quasi-integration" (Leborgne and Lipietz, 1988). In effect, the relationship between firms within such organisational forms is ultimately viewed as being close to a technical division of labour (Sayer,1989b). However, whatever these organisational relationships are eventually categorised as, the most important point is that whilst they represent a process of "externalisation", they do not also automatically represent a process of disintegration (or if they do it is a different form of disintegration

from that held by the model) and extension of the social division of labour. They reveal that the "correspondence" between certain processes of organisational change does not hold in all cases as implied by the transaction costs model. The "process-chain" is broken.

Moreover, a second example of "noncorrespondence", the multi-site firm, highlights that the chain may, in fact, be more appropriately viewed as a set of individual interchangeable "process links" (if only a partially understood and defined set as yet). Despite continued and renewed arguments for the theoretical integration of "the impossible dichotomy of social relations and space" (Massey,1984; Gregory and Urry,1985), a third implicit aspect of the model of the firm laid out above is its spatial structure. In the eyes of the model, it is assumed that the firm is a single-site firm. Therefore, by implication, the technical division of labour is bounded within a single site and the social division of labour stretches between different firms and hence different sites. So, externalisation corresponds with disintegration and disintegration corresponds with extension of the social division of labour.

Yet, one of the most distinguishing characteristics of modern capitalism is the appearance of the multi-site firm. Using the model such firms can be viewed, in one sense, as merely representing the spatial extension of the "internal" aspect of the firm to cover more than one site. Sites share the same owner and maintain hierarchically-governed relations between themselves. Effectively, such a situation

represents the extension of the technical division of labour over space. But, in other cases, multi-site firms exhibit the problem of "non-correspondence" whereby:

> "...the social division can penetrate *inside* different firms, where divisions make quite different and unrelated products selling in different markets and/or where there is market exchange between different divisions of a firm [such a *situation may occur on an inter*-plant basis or even an intra-plant basis]." (Sayer,1989b,p.678,author's *emphasis*).

In other words, market-governed relations imply a social division of labour **within** the firm whilst the criterion of ownership continues to imply a technical division of labour.

Such various organisational forms as strategic alliances and particular multi-site company structures place a large questionmark over the actual ability of the transaction costs model of the firm to cope with, and distinguish, the increasingly varied forms of industrial organisation (change) in modern capitalism. For example, the particular process of organisational change represented by the recent empirical identification of strategic alliances is not accounted for within the model as it stands. Moreover, it is unclear how such organisational forms can be accommodated within the model.[32] As Gordon (1989) writes:

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[32] Earlier, the recognition of such new organisational forms by Scott was acknowledged (pp.142-3). However, exactly how such forms can be accommodated within the model of the firm is not explained. In fact, as argued here, a flaw of the model is precisely its inability to include such organisational forms.

"The options presented by orthodox linkage theory - internal organisation or market-regulated transactions between independent firms - far from exhaust the possible forms of economic coordination. Indeed, they represent alternatives whose significance is diminishing in fact. The market-hierarchy dichotomy precisely obliterates the vast and expanding realm of non-market cooperation and coordination between firms that has emerged as a practical response to the limitations of both market and hierarchy alike." (op.cit.,p.28)

Gordon's point may also be extended to argue that this dichotomy likewise obliterates the varied forms of co-ordination to be found **within** (particularly multi-site) firms as well as between them.

At this point then, firstly, the theorised transition to flexible production has been debated. Secondly, it has been argued that this transition's motivation of a "process chain" of organisational change ultimately leading to the extension of the social division of labour is not automatic. Rather, it depends on a restrictive model of the firm and hence a restrictive model of organisational change by the firm. This process chain represents merely one of a series of possible forms of response by organisations faced with a new production environment.

Organisational change: a variety of responses (implying a variety of spatial outcomes)

Indeed, Martinelli and Schoenberger (1989) highlight a

critical organisational response which may be misread, arguing that:

> "...the increasing fragmentation of the productive system must not be confused with a fragmentation of capital and control...Counter and parallel to the fragmentation of the productive system there is a significant trend towards the further concentration of capital and control."(op.cit.,p.18-19).[33]

Significantly, Martinelli and Schoenberger (1989) still view this trend as part of the organisational response to flexible production. The appearance of strategic alliances, joint ventures and so on are argued to represent a new competitive structure of "flexible oligopoly". Similarly, Cooke (1988) has viewed such organisational forms as part of a turn to "flexible integration" in production.[34] In other words, there is a contradiction between the fragmentation of production, highlighted by Scott and Storper, and subsequently interpreted as the move to disintegration and extension of the social division of labour and the (parallel?) increased concentration of capital and control emphasised by other commentators and, in turn, interpreted as a move to integration and the (possible) continued extension of the technical division of labour.

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[33] Martinelli and Schoenberger (1989), as well as recognising the extension of ownership across more than one economic unit, are also suggesting that "control" may be wielded by one unit over another without a formal relation of ownership necessarily being present (see also Leborgne and Lipietz,1988,p.274).

[34] In contrast, Shutt and Whittington (1987) have also revealed this trend as the outcome of a different set of organisational responses. Namely "fragmentation" strategies by large firms in response to (the) crisis (of Fordism).

This contradiction is, in fact, no better highlighted than within the "US" film industry. For whilst this industry represents one of the strongest empirical justifications so far for the transformation of an industry into a disintegrated and flexible production complex (Christopherson and Storper,1986; Storper,1989) it has recently been rocked as "Hollywood rides into [the] Rising Sun" (Tran;1990). Following hard on the heels of Sony's takeover of Columbia Pictures, Matsushita (the world's 12th largest company) has announced its takeover of MCA.

Indeed, for Amin and Robins (1990), such an announcement merely serves to confirm their argument that, in fact, the combined trend of continued concentration and centralisation of capital is, if any trend of organisational change is, the trend of long term historical, and hence structural, significance. So much so, this trend fundamentally questions, in their eyes, the very shift to a new post-Fordist era:

> "...we are, in fact, witnessing a deepening of the historical trends towards global integration of local and national economies and the international centralisation of command and control. The dominant, though not uncontested, tendency is towards market homogenisation, industry globalisation and firm integration (Doz,1987)." (op.cit.,p.7)

However:

> "The new global corporations are following a range of strategies. They may, depending on the structure and dynamics

of particular sectors, refine 'older' forms of organisation involving direct ownership, forward and backward vertical integration, diversification into new profitable sectors and the internationalisation of production...

In other sectors, we can, in contrast, see the opening up of a range of 'new' possibilities, which also involve further international spread and the deployment of new communication technologies, but on the basis of developing much more fluid intra-firm and inter-firm organisational networks. MNCs, particularly in expanding industries characterised by intensive research and volatile markets (eg. telecommunications, computers, electronics, pharmaceuticals, aerospace, transportation equipment [ie. the industries of the flexible high technology ensemble], appear to be devising new strategies in the face of rising R&D costs, rapidly changing and shortening product life cycles, greater risks of market failure, and the availability of technologies which allow greater task integration and easier communication between divisions..." (ibid,p.10-11; cf. Financial Times Survey "European High Technology" 20.3.1990)

It is clear that new organisational forms such as strategic alliances, whether part of "flexible production and accumulation" or the antithesis of it, represent a process (or processes) of organisational change which is (are) not satisfactorily, if at all, encompassed within the transaction costs model of the firm as it is presently constructed.[35]

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[35] In fact, much work is still required to "unbundle" the group of organisational forms represented by strategic alliances, joint ventures, consortium, etc., especially as it is already known that a variety of strategies lie behind their creation (Cooke,1988; Gordon,1989).

Whilst the model's omission of the variety of processes of organisational change is a problem in itself, its particular importance for the New Industrial Spaces thesis stems from the theory's view that changes in the organisation of production drive changes in the spatial organisation of production. For the theory it is the specific organisational responses (under flexible production) of "externalisation", "disintegration" and "extension of the social division of labour" which trigger the "spatial mechanism" of agglomeration. However, such responses must be viewed as only a (model-restricted) "selection" of those currently underway. It therefore becomes highly questionable whether the spatial implications of all the current changes in the organisation of production can be accommodated within the New Industrial Spaces based, as it is, upon this restrictive model of organisational change.

Moreover, the continued complexity of modern industrial capitalism is revealing assumptions held within the transaction costs model to be increasingly untenable. Using it to decipher exactly where, and how, we draw the boundaries of the firm, and thus identify processes of dynamic organisational change (including those which trigger the "spatial mechanism") is becoming highly problematical. Fundamentally, however, **the ability to define firm boundaries, and exactly how this is done, is the most critical element in <u>the conceptualisation and operation of the locational mechanism</u> of the New Industrial Spaces thesis. For the "spatial mechanism" is an integral part of the**

firm once conceptualised within the transaction costs model.

<u>The "spatial mechanism"</u>

The boundary of the firm must be drawn before the "internal" and "external" linkages of any particular firm may be listed. This represents the critical moment in the conceptualisation of the firm and the spatial mechanism which is integral to it. For, as outlined earlier, the basis of the causal mechanism of location within the New Industrial Spaces logic is the argument that all linkages intrinsically possess a spatial cost and external production linkages possess a greater "spatial dependence" than internal ones. So, with an (assumed) increase in the proportion of external linkages ("externalisation") occurring in response to an (assumed) move to flexible production, the firm's linkage costs will rise. Subsequently, the pressures to reduce the spatial extent of these linkages may be recognised and, following the New Industrial Spaces thesis, acted upon by the individual firm through its location as part of an agglomeration. Furthermore, such a situation is deemed particularly likely if the firm's external production relations are characterised by high cost (transactions intensive) linkages involving highly flexible, uncertain and shifting connections, as is the reported case concerning the flexible industrial ensembles.

However, just as, and because, the multi-site firm raises problems for the transaction costs model of the firm, so it

raises problems for the locational mechanism which springs from this model. For, within such firms, **internal linkages occur within the firm but between sites.** In other words, such internal linkages are dispersed spatially, just as those external linkages between different firms, so begging the question how these former linkages can be treated as any less spatially dependent than the latter.

Just as two separate aspects have been identified which "determine" the greater spatial dependence of external linkages (pp.143-46), so these aspects are used to explain this anomaly. Effectively, the New Industrial Spaces thesis "disallows" the existence of this particular form of internal linkage. Firstly, on the basis of all linkages possessing a "unit cost per distance", **all internal linkages are assumed to be "on-site" hence highly spatially constrained.**[36] In the initial conception and application of the model, "internal" has been **equated** with "on-site" by explicitly **restricting the spatial model to single-site firms.** The model is still useful, however, due to the many empirical situations where industries and regions are predominantly populated by single-site firms. Indeed, the New Industrial Spaces are a particular case in point:

> "In much of what follows, firms are treated as though they were without exception single-plant (or single-establishment) units. This restriction simplifies certain aspects of the succeeding

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[36] The spatial scale being defined as relevant to the particular point being made.

discussion, and it certainly corresponds by and large to the empirically-given situation in the printed circuits and women's dress industries in the Greater Los Angeles Region today. Even so, it is a restriction that is clearly at odds with much of the reality of contemporary industrial enterprise, and any further elaborations of the present analysis will no doubt have to come more explicitly to terms with this issue."

(Scott,1983a,p.234-5).

Such further elaborations have followed an interesting line and eventually lead to the second form of response to spatially dispe*rsed internal* linkages, this time based on the nature of such linkages:

> "The situation becomes even more complicated when we take into account the circumstance that firms may, in addition, be spatially disintegrated into multiple discrete establishments, each of them with many independent external transactional relations." (Scott,1988b,p.25)

Essentially, whereas previously firms have been assumed to be single-site and independent, period, further elaborations have recognised the possibility that individual sites within a multi-site firm may well be acting as if "independent" (single-site) firms, with each site possessing its own network of external, market-governed linkages. In other words, **sites of multi-plant firms may be equated with independent firms.**[37]

[37] In fact, such treatment has been both explicit and implicit within Scott's empirical work. Concerning his work on Orange County (Scott,1986b), empirical investigation has revealed that in many cases "branches" do indeed have a high degree of autonomy so possibly justifying the equation. However, in other work, often involving aggregate data, the level of analysis used has been that of

Hence, the result of this second equation is that "internal" linkages that occur between sites owned by the same company actually become "external" linkages. Moreover, such linkages because they are external are more "flexible", "transaction-intensive" and hence costly. **Once again, the problematic of the spatial dependence of "internal" linkages is (partially) solved by effectively theorising such linkages into non-existence.**[38]

In effect, also, the form of multi-site firm organisation discussed earlier, whereby the social division of labour is seen to penetrate within the firm, is assumed. However, whilst such an assumption may be applicable to certain multi-site firms, it is questionable whether such an assumption can be made for all, or even the majority of, multi-site firms.[39]

"establishments" with no acknowledgement that such establishments may well be under the same ownership, although possibly acting "independently" (see later this chapter).

[38] I suggest only partially solved because no explicit conception of the spatial dependence of linkages internal to the site is actually held within the model. They are generally held to be just "less spatially dependent than external linkages". But, for example, linkages could be "on-site" precisely because they are highly transactions intensive and hence "resistant" to spatial dispersion. In other words, the model does not allow a situation where the mechanism could work "within site" (and possibly within multi-site). In other cases, looking at the production process itself, the actual process may be hampered by its spatial separation. For example, a critique of science parks is precisely that the phenomenon is based on the artificial spatial separation of two inherently inseparable processes of production, namely conception and manufacturing (Wield, Massey and Quintas,1988; Massey, Wield and Quintas forthcoming).

[39] In fact, Sayer (1989b) has recently lent some support to such a position, by suggesting the over-emphasis given to the ownership relation in determining the behaviour of multi-site firms. The rise of the "branch plant" as a stereotype in industrial geography may well be a case in point. However, the New Industrial

One further important "knock-on" effect of this assumption must also be emphasised. For if sites of multi-site firms are treated as "independent" then one process of their creation, namely the extension of the technical division of labour, becomes "null and void". **The extension of the social division of labour ("within" as well as between firms) becomes the only process of "new establishment growth".** This point is critical when discussing the empirical evidence thus far provided for the causal logic of the New Industrial Spaces (see later this chapter).

So, after highlighting certain assumptions concerning the spatial dependence of linkages, the New Industrial Spaces thesis puts forward a spatial mechanism which is an integral aspect of the firm (as conceptualised using transaction costs). However, in what amounts to a "reverse logic of necessity", it will be seen that the thesis also **puts forward a spatial mechanism with a necessary outcome, namely agglomeration.**

The mechanism's (non)operation...

Firstly, if we accept the existence of the causal mechanism as integral to the definition of the firm, we need not accept that the mechanism **operates each and every**

Spaces thesis effectively moves to the other extreme, replacing one multi-site organisational stereotype, the "branch plant", with another, "the independent branch". The point is how do we conceptualise the majority of multi-sites which sit somewhere between the two extremes? Sayer, himself, puts forward the idea of "modes of organization" where what matters is the emphasis placed upon the role of the market in governing relationships whether within or between firms.

time.[40] Certain conditions are required for the mechanism's activation. Indeed, Scott (1989) does set out those circumstances in which the mechanism will be activated. In other words, that "critical range" of transaction intensive production linkages (eg. small-scale, non-standard, flexible) whose costs particularly increase with distance.

...to create agglomeration

However, once the mechanism is activated, the argument continues that agglomeration will be the result. But this is not the case. Just as certain conditions are required to activate the mechanism so certain conditions are required for this activation to engender agglomeration. The mechanism's operation to create agglomeration is a contingent and not a necessary relation. **The possibility exists that the causal mechanism may operate without creating the outcome of agglomeration.**[41]

For example, despite doubt as to whether or not the transaction costs model can actually acknowledge the existence and repercussions of organisational forms such as strategic alliances, these organisational forms can be viewed as the "externalisation" of production by firms in response to the uncertainty engendered by structural

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[40] "So although causal powers exist necessarily by virtue of the nature of the objects which possess them, it is contingent whether they are either activated or exercised" (Sayer, 1984,p.99)

[41] "When they are exercised, the actual effects of causal mechanisms will again depend upon the conditions in which they work... Not surprisingly then, depending on conditions, the operation of the same mechanism can produce quite different results..." (Sayer,1984,p.99-100)

change. They are an integral element of the transition (to flexible production). Hence, these forms also represent an expansion of "flexible (?) external linkages" within production. In other words, an expansion of those linkages which are viewed as driving the primary dynamic of agglomeration within the New Industrial Spaces. Strategic alliances may yet represent a process of "externalisation" under flexible production, triggering the spatial mechanism, and so driving the tendency of agglomeration. However, the tentative empirical evidence so far suggests that strategic alliances take a variety of spatial forms. Cooke (1988) concludes that:

> "...the spatial picture is one of *locationally relatively unconstrained* networking of information, R&D, marketing, and distribution, much of which is tied together by the burgeoning trend towards forming strategic alliances". (op.cit., p.296, author's emphasis)

His small study of a US biotechnology complex similarly found that most alliances were nonlocal (ibid).

Gordon (forthcoming) discovered that an astonishing 90% of a sample of high technology SMEs in Silicon Valley were involved in alliances:

> " Alliance relations link SMEs almost exclusively with other large (80 percent), established (94.4 percent) high technology firms in an intricate global network. The majority of firms maintain partnering linkages at the local, national and international levels simultaneously." (op.cit.,p.36,my

emphasis)

The strongest evidence yet for the agglomeration of such linkages has been provided by Saxenian (1990). She has detailed the ways in which computer systems firms in Silicon Valley are consciously creating networks of long-term, trust-based alliances with their most innovative suppliers but again both within, and outside of, the region:

> "There is, however, a clear trend for Silicon Valley systems firms to prefer local suppliers and to build the sort of collaborative relationships which flourish only with proximity."(op.cit,p.32)

Thus it is evident that strategic alliances and the like vary considerably in their spatial extent from the local to the global. The question is how can this be.

The implication of the New Industrial Spaces logic is that spatially diffuse production linkages "fail to gain membership" of that "critical" set of production linkages which engender agglomeration:

> "The point here is not that such wider interactions do not occur, but that there is, in addition, some critical range of inter-industrial activities whose cost-distance relations encourage agglomeration of groups of producers into distinctive industrial districts and regions. This critical range would seem especially to be made up of transactions-intensive (hence high cost) linkages involving above all flexible, rapidly-

> shifting, small scale, and non-standard connections between producers." (Scott,1989,p.26)

The point here, also, is that in terms of the operation of the mechanism, **where the "outcome of agglomeration" is not present it is presumed that the conditions for the operation of the mechanism are also not present. Whilst that may be so, it may also be the case that the mechanism is operational but an outcome other than agglomeration transpires. The New Industrial Spaces thesis includes, in effect, a "reverse" logic of necessity.**

Thus, concerning strategic alliances, if one follows the transaction costs approach, the implication is that global alliances must somehow differ in terms of linkage type (ie. less transactions-intensive, flexible etc.) to those alliances of local dimension, so explaining the **non-operation** of the mechanism. Whilst the above quote of Saxenian (1990) lends some support in suggesting that certain alliance relationships can only flourish with proximity, work by Hamel et al.(1989) on predominantly inter-continental alliances has equally revealed how such alliances involve a constantly evolving bargain requiring continual monitoring, appraisal and adaptation by partner companies, both individually and in unison. In other words, such global linkages arguably share many characteristics of transaction intensive "linkages of agglomeration" (whether alliance-based or not), not least of which is the shared driving force behind their creation, namely the search for *external economies of scale and scope*.[42] The conclusion

must be drawn that the mechanism is activated in cases of both local and global strategic alliances but only produces agglomeration in the former case. In the case of global alliances the mechanism **is operative but "overridden"** by other "contingent conditions".[43]

This fundamental point may be further illustrated by the work of Glasmeier (1988) and Gordon (forthcoming). In her studies of high technology multi-site firms Glasmeier (1988) has described a particular form of branch plant, the "technical branch plant". This form of branch plant encompasses its own product-related R&D, is involved in market relations with its parent and, as such, is viewed as a stand-alone profit centre by its parent. Such a plant would seem to represent an empirical example of those "branches" Scott has himself equated with independent single site firms. Yet on studying such a technical branch plant, located in Austin, Texas, Glasmeier (1988) concluded that:

> "In the case of Rolm in Austin, limitations on linkage and spin-off development arise because the Rolm-Austin plant is a technical branch plant whose parent is located in Silicon Valley. While ideally the Rolm-Austin plant would like to, and certainly could take advantage of local suppliers, it does not do so for the most part because input needs are satisfied

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[42] Concerning the driving force for "linkages of agglomeration" see the earlier quotes of Scott (this chapter). For strategic alliances see the work of Teece (1980) quoted in Cooke (1988,p.290).

[43] This point raises an important issue for "realist" based empirical research. That is, how may we distinguish situations where the mechanism is not operational from those situations where the mechanism is operational but overridden.

> through the parent corporation which is strategically located in a dominant high tech agglomeration, California's Silicon Valley." (op.cit.,p.295)

In other words, despite the availability of local suppliers and hence (presumably) the ability to reduce the spatial cost of these supply linkages such a situation is precluded by the role of the parent. **The mechanism would seem to be operative but "overridden".** It may be argued that this is the case because the move to full "marketisation" has not taken place, hence the optimum conditions for the logic to apply have not been reached. Although the branch is viewed as a "profit centre" it is restricted by the parent as to the advantage it may take of (presumably) cheaper local linkages. However, this precisely highlights that certain conditions are required for the mechanism's activation, period, and its activation to produce an agglomeration outcome. The mechanism's operation is not automatic and nor is the outcome of agglomeration from its operation.

The recent work of Gordon (forthcoming) provides a further example and, in so doing, returns our attention to the conceptualisation of the firm as a production organisation encompassing more than just a series of market relations. For in his work Gordon describes how the present environment of permanent innovation and rapid technological change is driving the formation of new forms of firm relationship within high technology industries. No individual firm is able to cope alone in such an environment and survival is based on a combined strategy of

specialisation and "integration" (disintegration?!) into a network of interconnected firms providing complementary specialist services. In fact, this scenario mirrors that of the New Industrial Spaces thesis. However, where it differs is Gordon's (forthcoming) argument that:

> "The central problem for the individual firm is no longer a discrete series of traditional "make or buy" decisions, but the coherent allocation of its activities within the structure of internal operations, market exchange, and interdependent relations that comprise a *chain of production*...The logic of production must be defined not simply in terms of an efficient combination of factors but as a logic of interaction..." (op.cit,p.38,author's emphasis)

Whilst such a logic is creating new forms of economic coordination excluded from the traditional "make or buy" dichotomy, it also holds a critical impact on the (locational) behaviour of the firm. For:

> "Transaction-intensive and non-standardised relations also appear to sustain less geographically-dependent cost structures than is frequently thought or at the very least, the agglomerative tendencies inherent in transaction costs are outweighed by other production-oriented considerations." (Gordon,forthcoming,p.37,my emphasis)

For the individual enterprise the critical issue becomes its positioning within networks of firms that constitute a **chain of production**, encompassing both the unique innovative capabilities of local innovative complexes and

entry into the global information networks of regional economies (ibid.,p.39). Whilst "transaction costs" **may** be an issue, particularly concerning the local element of the production network, it is clear that the significance of production linkages is, first and foremost, based on why they are created and who with, rather than costs incurred as a result of where they are created.

In contrast to Gordon (forthcoming) and Glasmeier's (1988) work, Saxenian (1990) has provided evidence of the operation of the transaction costs mechanism to produce agglomeration. Interviewing computer systems firms in Silicon Valley, the following typical quotes of managers were gained:

> "Our purchasing strategy is that our vendor base is close to where we're doing business...We like them to be next door. If they can't, they need to be able to project an image like they are next door."
>
> "In the ideal world, we'd draw a 100 mile radius and have all our suppliers locate plants, or at least supply depots, into the area." (Saxenian,1990,p.17)

The argument, then, is not to deny that agglomeration is an outcome of the "transaction costs" mechanism but rather to argue that it is not a **necessary** result of its operation. In effect, the New Industrial Spaces thesis incorporates a **reverse logic of necessity** <u>in that the non-appearance of agglomeration implies the non-operation of the mechanism</u>. In fact, the mechanism may be "overriden" and Gordon's (forthcoming) and Glasmeier's (1988) work reveals

"conditions" in which this may take place. Moreover, they reveal conditions which are integral aspects of the firm yet are excluded from the transaction costs model. Gordon (forthcoming) refers to "production-oriented considerations" which arise from viewing the firm as node of interaction in a production chain rather than merely an efficient point of factor combination. Thus, he argues that:

> "More broadly, the conception of linkages as relations of exchange remains preoccupied with the costs and geographic scope, as opposed to the actual content, of inter-firm relations." (Gordon,1989,p.27)

Whilst this is a view recognised by Scott and Storper, the preoccupation implies that it is less clear whether they recognise that specific elements of this linkage content may precisely represent other "conditions (contingencies)" determining the operation and outcome of the mechanism.

Gordon highlights the actual process of production but a further, and highly relevant, aspect is that of power relations. For whether exercised through ownership, hierarchically-, market- or "intermediately"- governed linkages, each site is necessarily placed within a system of power relationships through its linkages with other sites, just as it is necessarily placed within a transactional cost structure (Storper and Harrison,1989). Moreover, it is clear that "power" within relationships can play a role in location. Thus, in the earlier discussion of Glasmeier's (1988) work on the Rolm branch in Austin, the

"parental" relation (ie.the power of ownership) precluded the use of local supplier linkages. In contrast, it has been shown how assumptions made when conceptualising the spatial model precisely remove such a (definitional) relation for "branch" sites. They are viewed as independent firms.

This example is symptomatic of the model as a whole. For whilst Scott (see p.143) acknowledges "various kinds of power relations" within quasi-hierarchical or quasi-market linkages, he fails systematically to allow for the fact that such power relations may influence the (non)operation and outcome of the locational mechanism. Linkages between sites are implicitly assumed to represent relationships of equal power. Yet, we merely need look at one form of linkage between a large customer and its dependent subcontractor to exemplify one possible (asymmetrical) power relationship. The point is, however, that such power may also play a role in the locational decision.

For example, situations are increasingly being brought to our attention where the introduction of J.I.T. systems by a large firm is requiring a similar move by its suppliers to become part of a complete production system. It is also argued that the successful working of J.I.T. systems requires locational proximity (Estall,1985; Holmes,1985; Sayer,1985b; Sheard,1983). Hence, the dependent subcontractor is required to locate "close" to the major customer at the behest of this customer. In such a case the subcontractor's locational decision is circumscribed by the unequal power relationship contained within its linkage.

Whilst it may be argued that the ultimate reason for locational proximity returns us to transaction costs pressures mediated through the J.I.T. production system, the subcontractor's minority power within this production linkage cannot be overlooked. Its dependence on this customer (rather than many) shapes its locational decision. The point is that power is also a highly important **ever-present** aspect to production linkages (just as transaction costs are) which may or may not intervene in the (non)operation of the causal mechanism of location.

Certainly, power may influence how we view the outcome. For example, the contractor-dependent subcontractor agglomeration linkage is considerably different from the linkage exemplified within the canonical industrial district. This latter form of agglomeration, often taken as exemplary of the New Industrial Spaces logic (see later this chapter), is viewed as representing networks of small family firms of equal position within an essentially non-hierarchical production system. In fact, in recognising this issue, Storper and Harrison (1989) have used the form of power relation (governance structure) as a discriminating variable in the creation of a typology of production agglomerations, and production systems more widely.

Other mechanisms of agglomeration

The corollary of the mechanism possibly producing other outcomes than agglomeration, is that agglomeration itself may be the empirical result of different mechanisms. Other

mechanisms may act to create a similar agglomeration pattern as that generally attributed to the "transaction costs" mechanism.[44] Indeed, Scott and Storper provide a variety of mechanisms of agglomeration within the New Industrial Spaces thesis (see pp.144-49).

For example, the thesis argues for agglomeration as a result of the "externalisation" process undertaken by firms to take advantage of the (agglomeration) economies potentially achievable through having other specialist firms "close". That is, firms already within the production network are likely to increase their external linkages to it. This represents the dynamic concept of "locational implosion" of an agglomeration.[45] However, the key dynamic of such agglomerations, in the first instance, is Scott and Storper's view that the drive by firms to become part of these networks, and hence gain from the economies of such networks, will create a spatial tendency for firms to cluster. In other words, linkages with the network will engender a "spatial pull" and become a crucial element in the location of firms within the spatial boundaries of such

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[44] "When they are exercised, the actual effects of causal mechanisms will again depend upon the conditions in which they work... Not surprisingly then, depending on conditions, the operation of the same mechanism can produce quite different results and, alternatively, different mechanisms may produce the same empirical result." (Sayer,1984,p.99-100)

[45] However, this "dynamic" of agglomeration does raise certain questions about the concept of agglomeration itself. For example, "externalisation" may simply represent the swopping of internal linkages for external linkages but these "new" external linkages, if based within the local production network, will be viewed as adding to the agglomeration. In reality, however, the same number of linkages (whether internal or external) will be found within the locality begging the question why the term "agglomeration" is applied in only the latter instance [I thank Doreen Massey for this point].

networks.

But, in the light of Scott and Storper's argument for a locational mechanism of agglomeration, a critical distinction between the two processes of agglomeration needs to be drawn. For in the former instance, linkages within the agglomeration are set-up **post-location.** Such linkages may well be of crucial significance to the continued well-being of the individual firm (and the production network). However, our concern in this instance is the role of linkages *vis-a-vis* the actual process of location, and it is clear that concerning this relationship such linkages are **contingent.** The reason for the firm's location lies elsewhere. That reason may possibly be the latter mechanism of agglomeration provided by Scott and Storper, whereby linkages are part of the location dynamic. In this case, linkages within the agglomeration are created **pre-location or upon location** and are an integral element in the firm's location. **Thus, whilst the outcome of agglomeration occurs in both instances, the causal process is different to the extent that only in one case is the process actually causing a change in location.**

Problems of theory and method (Sayer,1985c)

In summary, whilst the necessary existence of the spatial mechanism as part of the (transaction costs) firm may be accepted, neither this mechanism's necessary operation nor its necessary operation to produce agglomeration is acceptable.

The New Industrial Spaces spatial logic certainly does not fall into the trap of "crude determinism" in arguing for the necessity of the mechanism's operation to create agglomeration.[46] However, it does contain what may be viewed as a **reverse logic of necessity.** For if agglomeration is not present it is therefore also assumed that the mechanism is not present (non-operative). But this is not the case. Rather, it is contingent as to whether or not agglomeration will result from the activation of the mechanism. Moreover, it is argued that greater understanding of such "contingency" is forthcoming if we **view the firm as rather more than just a transactional structure representing also the organisation of the social relations of production.**

In effect, the logic falls into the trap of many theoretical stereotypes in practical use (Sayer,1985c):

> "At a general methodological level, the basic failing of all these stereotypes is that they freeze, and then present as universal, relationships which are contingent and historically specific. They therefore combine problems A and B in section 2 (pseudoconcrete analysis and misidentification of space and process)..." (op.cit.,p.17)

The logic implies "pseudoconcrete analysis" in that it fetishises agglomeration (a transient and contingent social form) as the only spatial outcome if the transaction costs mechanism is activated under flexible production (Sayer,1985b,p.4). It implies the problem of

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[46] At least, it does not do so theoretically. However, in its use of empirical evidence the theory moves perilously close to doing so (see later this chapter).

"misidentification of space and process" by identifying a particular process, the transaction costs mechanism, with a particular space, agglomeration. In fact, more directly, the logic implies "misidentification" by identifying the non-existence of the space (agglomeration) with the non-operation of the process (transaction costs)[op.cit.,p.5].

In combination, this analysis of the mechanism and its operation therefore implies that rather than seeing agglomeration as the outcome of the transaction costs mechanism, period, it rather becomes a question of what weight we actually give to the transaction costs mechanism as one explanation (of several) of agglomeration. In other words, whilst the mechanism represents a coherent theoretical "logic of agglomeration", what evidence is there that it also represents an empirically-realised causal mechanism of agglomeration? Fundamentally, it is this evidence which will thus determine to what extent the spatial logic of the New Industrial Spaces truly represents the locational logic of the theorised (and hotly contested) transition to a post-Fordist industrial society.

Also fundamental, however, is the form such empirical evidence must take in the light of this analysis of the operation of the causal mechanism. For the analysis implies that we cannot simply provide the logic of a mechanism (eg.transaction costs) and empirical evidence akin to the perceived outcome of the mechanism (eg.agglomeration). For,

in reality, the mechanism may or may not have operated in the particular instance to produce the particular outcome. Rather, empirical evidence must be provided which identifies the mechanism and its operation to produce the outcome. **In other words, the nature of the causal process creating any (outcome) pattern must be investigated as well as the outcome, itself, described.**

<u>The (empirical) appearance of new agglomerations of production: The New Industrial Spaces.</u>

The preceding section has outlined how the process of spatial agglomeration has been theorised by Scott (and Storper) and questions have been raised concerning certain aspects of this theorisation. Furthermore, the section has ended by highlighting the critical importance of empirical evidence in confirming the "status" of the theoretical logic put forward. The following section deals with the empirical evidence, both for the **pattern** of spatial agglomeration and for the theorised **causal process** from which the pattern is said to have arisen. As such, two dimensions of this evidence will be focussed upon in particular.

Firstly, the actual empirical evidence which is the content of the pattern will be discussed. However, as has already been emphasised, this evidence will also be evaluated for evidence of the causal process behind the pattern. Merely exhibiting the outcome, and assuming its appearance as due to a particular posited mechanism is not enough. Evidence

for the operation of that particular causal process in creating that particular outcome must also be provided.

This requirement as to what the evidence needs to exhibit, that is both process and outcome, leads to the second dimension concerning the empirical evidence. That dimension is the method used in the collection of empirical evidence. For it is argued that particular, and different, research designs are required depending on whether evidence is being collated of a causal process or of a pattern of outcomes (Sayer,1984).

Distinguishing marks: What are the empirical features of a New Industrial Space?

As was the case when earlier detailing debates around the move to post-Fordism, so the empirical evidence for the New Industrial Spaces has been subjected to a variety of "readings". Once again, the interpretation of empirical evidence by Scott and Storper has been the subject of criticism (see, for example, Amin and Robins,1989; Amin,1989; Lovering,1990; Murray,1987).

At one level, such criticism has arisen in the face of rather zealous classification and listing of a whole gamut of regions of growth throughout Western Europe and North America as New Industrial Spaces (Scott,1988a). Yet, more specifically, the arguments are essentially about what exactly are the empirical features which represent the definitional characteristics of a New Industrial Space (and

most especially, but often overlooked, identify the causal processes which create such empirical phenomena). A more detailed discussion of the "empirical characteristics" used by Scott in the identification of a New Industrial Space takes place in the following chapter but, at this juncture, the conceptual definition providing a framework for such characteristics may be outlined.

Essentially, the New Industrial Spaces refer to regions characterised by a localized production system incorporating a deep division of labour between producers but which also entail a supportive tissue of social practices and institutions. Each region represents a (rapidly growing) spatial agglomeration of firms combined through a dense network of linkages. These linkages occur both directly, through the production process itself, and indirectly, through the wider social and political, as well as economic, "environment" which is created by groups of closely related producers. In practice, such a definition has been widely equated with that of the "industrial district" and, in particular, that type represented by the "Third Italy" region (cf. Amin,1989; Becattini,1978; Brusco,1982; 1986; Garofoli,1984; Russo,1985). Indeed, the "Third Italy" has been used by Scott (1988b) as an exemplar of a New Industrial Space.

However, questions have been raised concerning whether or not such industrial districts are a widely generalized, or generalizable, phenomenon (Amin and Robins,1989; 1990; Martinelli and Schoenberger,1989). For many case studies of regional production systems claiming to represent

industrial districts have differed significantly in terms of sectors, firm size, production type, institutions, "environment", etc., leading to the suspicion that the only aspect which links such disparate regions is actually their position as regions of economic growth. Whilst such growth regions create a pattern of hope and success, at least for some of their inhabitants (Amin,1989; Murray,1987; Storper and Scott,1988), the argument has continued that their association is merely that of success and not the shape or cause of that success (Amin and Robins,1989).

Two responses to such criticism are evident. Firstly, it is argued that the form of industrial district found within the "Third Italy" by no means exhausts the possible variety of empirical forms such districts may take. Hence, for example, the work of Storper and Harrison (1989) who:

> "Note that, in principle, industrial districts <u>as we are defining them here</u> are not restricted to cases where there are <u>only</u> small- and medium- sized units of production [ie. the 'Third Italy' stereotype]; they can have a mix of small and large units." (op.cit,p.10,authors' emphasis)"

Secondly, and related to the evidence of empirical variety, New Industrial Spaces have been theorised not as similar in terms of outcome but rather as structurally related regions each with its own individual and unique characteristics,[47] and related by their shared causal dynamic. They are not carbon copies of the Third Italy and the forms of

[47] However, it should be noted that whilst variety in terms of type of agglomeration is allowed for, it was earlier seen how the tendency to agglomeration itself is theorised as a necessary outcome.

industrial district to be found within it, but they are:

> "...nonetheless analytically part of the same family tree." (Storper,1990,p.2)

In fact, the family tree, as already outlined, is defined by:

> "...the social division of labour, the formation of external economies, the dissolution of labour market rigidities, and the reagglomeration of production." (Scott,1988a,p.181)

However, one further point does need to be made at this stage. For whilst any New Industrial Space must be a localized production complex, a localized production complex need not be a New Industrial Space. For the New Industrial Spaces are the geographical (and historically specific) consequence of the present period of capitalist restructuring. Localized production systems, in contrast, are a recurrent empirical feature of the industrial history of capitalist development (Sabel and Zeitlin,1985). The New Industrial Spaces merely represent the most recent ("flexible") historical form of such complexes associated, in particular, with the rise of the new flexible industrial ensembles.[48] However, it is argued by Scott that all such localised production complexes throughout history do share the same causal dynamic(s) and:

> "...we can often best understand the evolutionary dynamic of localized production complexes (especially those formed,

[48] I thank Allan Cochrane, in particular, for this insight.

and forming, in the context of the new regime of flexible accumulation) in terms of an unremitting *endogenous* logic of the division of labour and (via external economies of scale) the formation of intense agglomeration economies." (Scott,1988b,p.18,my emphasis in bold)

But, if we recognise the validity of this argument, it then must shift our understanding of, and debates on, the empirical evidence. For within such a framework each New Industrial Space may indeed represent a concrete outcome significantly different in many "industrial characteristics" when contrasted with its relations. However, this is not the case concerning empirical evidence for the causal process of each region's growth. **It is this process which is common to all the New Industrial Spaces and hence empirical evidence of this process must similarly be present for all the spaces.**

Thus, whilst one can argue about the data which is used to characterise the "empirical outcomes" (ie. whether or not the data is similar and common between regions), and argument does abound, of more significance is the evidence provided of the causal process (the transaction costs mechanism?) which is creating the phenomenon which we are attempting to characterise. For evidence for this mechanism **and its operation** must be clearly available in each and every example of a "space". Once identified it then becomes a question of deciding whether the mechanism and its spatial outcome is the result of the present "flexible" restructuring of capital or that of a historically

different period. However, and as already suggested, providing proof of a causal mechanism involves significantly different research tools than when providing evidence of an outcome.

The following section will therefore outline the (lack of) evidence for the operation of the causal mechanism (or at least the lack of presentation of such evidence) within those regions specifically pinpointed as New Industrial Spaces *par excellence*. More fundamentally, however, it will show that those attempts so far to gain such evidence for the causal process have been doomed to failure from the start. For the methodology employed in these attempts simply <u>cannot</u> produce the particular form of evidence required, namely evidence of the operation of a causal mechanism.

Evidence for an (agglomeration) outcome

Scott has undertaken almost a decade of empirical research into a variety of production agglomerations (initially defined both by industry and spatial region, although of course intrinsic to the New Industrial Spaces is the coalescence of industry with space into a single entity). These agglomerations range from his earliest work, such as on the women's dress industry and printed circuits industry in Greater Los Angeles, to most recently, the Third Italy; the Scientific City (Ile de France South); Silicon Valley; a return to the printed circuits industry of Southern California as a whole; and a study of other high technology

technopoles also to be found within Southern California (Scott,1983b; 1984; 1988b; 1989; Scott and Kwok,1989). The initial basis of all this research has been to map the concentration of establishments of a particular "flexible industrial ensemble" within a particular region. By doing so, Scott has clearly identified some of the most important production agglomerations of the advanced Western economies. He has clearly identified a series of "agglomeration outcomes".

A particular example is that of his work on Silicon Valley, an agglomeration of semiconductor producers in Santa Clara Valley, California (Scott,1988b). Scott initially describes the growth, and rise to structural prominence, of the semiconductor industry within Santa Clara Valley (Silicon Valley). Between 1964 and 1985 employment in the semiconductor industry (SIC 3674) of Silicon Valley rose from 3,994 to 47,069 (op.cit.,Table 7.5). Hence, by 1982, employment in the industry accounted for 18 per cent of all manufacturing employment.

Further, Scott highlights in his study how this modern flexible sector *par excellence* (op.cit.,p.78) is a foundation for a greater high technology flexible ensemble within the region. Taking the core high-technology complex as four SIC sectors (machinery; electric and electronic equipment; transportation equipment; and instruments and related products), Scott traces the employment growth of these industries from 23,774 in 1962 to 228,873 in 1982, representing an increase from 31 per cent to 81 per cent of total manufacturing employment. Within this core, the

semiconductor industry has increased its share but, as Scott notes, numerically, the electronic computing equipment industry now employs a greater number of workers. However, semiconductors have undoubtedly acted as the "propulsive" sector providing the foundational dynamic to the larger high technology ensemble, including electronic computing equipment, now present in Silicon Valley.

Once the role of the semiconductor industry in the history of Silicon Valley has been depicted, Scott then goes on to describe the importance of Silicon Valley in the industrial geography of the US semiconductor industry. The first aspect he notes is the growth of the semiconductor industry irrespective of its geography. Employing 23,4000 in 1958, by 1982 the industry employed 1,665,000 (op.cit.,Table 7.1). However, a geographical breakdown of these figures shows two particular shifts over time in the spatial distribution of this employment (op.cit.,Table 7.2).

Firstly, in 1958 it was clear that the geographical centre of the industry was not Silicon Valley but the Northeast of the US. In 1958, 63.6% of all employment in the industry was located in New England and the Mid-Atlantic states. In comparison, California contained only 19.9% of employment in the industry at this time (op.cit.,p.82). By 1982, however, California had increased its share to 28.7% of employment, in a period when the industry as a whole saw dramatic employment growth, giving the state the largest concentration of employment in the country. In comparison, the states of New England and Mid-Atlantic had seen a significant reduction in their percentage share (not

numbers) of the country's semiconductor employment.

This relative decline was not due only to the growth of California as the spatial focus of semiconductor industry. The second geographical shift which had occurred was that of locational dispersal such that by 1982 a pattern of wider geographical distribution of semiconductor employment was evident. Hence, there were significant centres of semiconductor employment to be found in Texas and Arizona as well as other new locations such as Florida and East North Central (Table 7.2). Yet, as suggested above, this process of dispersal had occurred simultaneously with greater concentration of employment within California. And within California is found Silicon Valley which has become the internal centre of this geographical concentration such that, by 1984, 69.2% of California's semiconductor employment was to be found in Silicon Valley (op.cit., p.82).

Hence, Scott shows how Silicon Valley has over the last decades become the geographical centre of one of the most significant industries of the last few decades, namely semiconductor production. In turn, he goes on to identify a wider set of agglomeration characteristics created through this growth.

"Disintegration causes agglomeration and agglomeration causes disintegration" so he identifies the:

> "...phalanx of specialized input suppliers and subcontractors who constitute one of the important sources of agglomeration

economies in the region." (Scott,1988b,p.94)

Moreover:

> "The agglomeration economies of Silicon Valley have been further intensified by the development of large populations in local urban communities. These populations are the basis of extensive labor markets in electronics personnel." (op.cit.,p.92)

These local labour markets coincide with the wider imperatives of the new "flexible" production era in being distinctive by their fluidity. The social formation within the region is such that on the one hand, there exists a large pool of skilled technical and engineering workers who are high-waged but also mobile. On the other hand, and exhibiting the bifurcated employment structure within the Valley's semiconductor industry, is a large proportion of Hispanic and Asian immigrants who act as a constantly expanding pool of (flexible) low-waged, unskilled non-unionized workers (op.cit.,p.92).

Silicon Valley, it may be concluded, has become the most potent of recent examples of (high technology and flexible) production agglomeration. The remaining question is whether or not it is a New Industrial Space. For the question remains as to what is the causal process of this outcome and, indeed, all the "agglomeration outcomes" Scott describes.

Evidence for a (transaction costs) causal mechanism

Scott puts forward two forms of evidence for the growth dynamics of production agglomerations which confirms them, in his eyes, to be New Industrial Spaces (Scott,1988b). Firstly, in the case of Silicon Valley, Scott has shown how the steady growth in the region's semiconductor employment over the period 1964 to 1985 has been accompanied by a similarly steady growth in the number of establishments from 7 in 1964 to 136 in 1985. Furthermore, he describes the expansion of other selected high technology sectors in the region which are associated with semiconductor production. Hence, such growth represents the key "trigger" process of the extension of the social division of labour.

Whilst the evidence does suggest the extension of the social division of labour an initial reservation must be raised. As highlighted earlier, this reservation is based on the conceptual difference between establishments and firms. Hence, some of this establishment growth is almost certainly attributable to "branches" and therefore may be attributable to the spatial extension of the technical division of labour, rather than the extension of the social division of labour. However, it may also be recalled from earlier, that such a possibility is effectively "theorised away" within the logic of the New Industrial Spaces by a number of means, although exactly what form applies in this instance is difficult to tell.

Moreover, notwithstanding this reservation, **the mere appearance of (a pattern) of increased numbers of**

establishments within the "spatial confine" of Silicon Valley, does not provide any information as to the locational process(es) which has created the pattern. However, in Scott's eyes, and following through the necessary spatial logic of the New Industrial Spaces, the "fact" that most (?) of an agglomerated set of establishments appear to have been created through the process of the extension of the social division of labour, suggests an "externalisation" process has taken place, and implies that the transaction costs mechanism will have been triggered so leading to their agglomeration.

So, for example, in a partial survey (numbering 80 *establishments*) of the numerically growing (flexible production) industry of biotechnology in the Ile De France (Scientific City) region, Scott (1988b) maps two clusters of between 10 and 15 establishments. From this he concludes that:

> **"The biotechnology industry (or at least parts of it) in the Scientific City thus appears to be in the incipient phases of spatial nucleation and differentiation. It is probable that these tendencies are based on increasing interunit linkage...though only scattered and partial evidence is currently available." (op.cit.,p.74)**

The evidence is indeed extremely partial, although Scott does identify what would be required as "conclusive" evidence, namely inter-unit linkages. However, and in concurrence with Gordon (forthcoming), it needs to be stressed that:

"Theories of industrial recentralization have tended to base their speculations upon purely presumptive linkages between firms in the same locality. Most often, these arguments are tautologous, the fact of agglomeration serving as evidence for the existence of inter-firm linkages. Contiguity, however, does not generate synergy of linkage as a matter of course and firms may locate in the same area for reasons that have nothing to do with linkage requirements." (op.cit.,p.2-3)

Providing evidence of agglomeration (the outcome) does not provide evidence of the process behind such agglomeration. More so, evidence of "externalisation" does not provide evidence of the causal process. Firstly, it says nothing about whether those external linkages created are local or not (ie. is the agglomeration a localised production complex or a "conglomerate" of spatially clustered firms) and, secondly, it says nothing about whether any local linkages created actually played a role in the location process of the firm (eg. the difference between linkages created pre- or post location). **Such evidence merely <u>infers causality</u> on the basis of a pre-theorised logic.**

In the worst "eulogies" on the New Industrial Spaces, little more evidence than simply the fact of spatial agglomeration and the availability of "agglomeration economies", such as specialised research institutes, is put forward to support the theorised causal mechanism. But Scott has acknowledged the need to provide evidence of local inter-unit linkages, evidence of a local production

network, through which the mechanism does (or at least can) act and in some of his work has attempted to do so. Evidence of such linkage networks, in Scott's eyes, also represents the second form of evidence of the causal process.

Hence in his work on Silicon Valley, having described the agglomeration, Scott set out to exhibit how those semiconductor establishments to be found within the Valley differed in characteristics from those found elsewhere in the USA (Scott,1988b). Such differences are subsequently argued to be attributable to the unique agglomeration economies to be found within the Valley and both drive, and are the product of, the local production complex.

After compiling an almost complete list of on-shore semiconductor producers within the USA, numbering 590 *establishments*, Scott sent a postal questionnaire to each entry. This questionnaire covered employment, technology, outputs, external linkages, ownership, etc., and achieved a response rate of *10% or 60* establishments, although full information was not provided by all the returns. He then undertook discriminant analysis of the returns to identify any differences between the two groups, Silicon Valley producers and non-Silicon Valley producers, for a large variety of variables, and on *sample numbers ranging from 15 up to 44*.

From his work, Scott was able to identify characteristics specific to the Silicon Valley producers which would imply transactional structures made up precisely of those "inter-

industrial critical linkages" of which spatial costs are a significant element (ie.flexible, rapidly-shifting, small-scale and non-standard):

> "First, the revealed high percentage of research and development workers employed by Silicon Valley semiconductor establishments suggests that this region is a hotbed of technological innovation (both in processes and products) for the industry as a whole. Second, the relatively large diameter wafers used by Silicon-Valley producers is testimony to their leading-edge status...Third, the finding that merchant producers are strongly attracted to Silicon Valley whereas captive plants are overwhelmingly located elsewhere is symptomatic of the peculiar external transactional relations of these two types of producers...Fourth and last, and in direct corroboration of all the above, we find that Silicon-Valley producers sell a much higher proportion of their merchant output to customers in their immediate vicinity than do establishments in other parts of the country." (Scott, 1988b, p.100)

Hence, Scott concludes that:

> "This indicates that semiconductor production in Silicon Valley is in part sustained by a closely knit web of *intra*regional transactional relations among many different independent but functionally related producers. This result adds further credence to the argument concerning the transactional economies to be derived from locating in the specialized production complex of Silicon Valley." (ibid.)

Scott has provided evidence of a local production complex and the agglomeration economies which may be derived from it. Unfortunately this is all he does. Even though a pattern of local linkages is now known to exist, this still does not meet the second and essential point made earlier. **The evidence still says nothing about whether or not these linkages played a role in the locational dynamic of these establishments.**

Essentially, only a more detailed (and necessary in its own way) picture of the "outcome" has been provided. Not only has the **pattern** of spatial clustering of firms been depicted but, also, shown through a **pattern** of linkages, is the fact that these firms are not merely discrete production units, but are actually connected within some form of local production network. However, the mere existence of linkages between (spatially close) firms says nothing about the **process** of their creation. **In turn, if the process of linkage creation is still to be revealed, then so too is the alleged working of the spatial mechanism which is an integral part of this process.** Simply put, in the example of Silicon Valley or any others he has undertaken, Scott has failed to ask whether or not local production linkages have or have not played a role in establishments' location decisions. Rather he has merely provided evidence of the existence of such linkages.

To reiterate the point made earlier, the nature of the process (linkage creation), and not merely the perceived outcome (aggglomerations of linkages), must be investigated and empirical evidence provided on this basis if we are to

accept the locational mechanism of the New Industrial Spaces. However, to gain such evidence requires an "intensive" research methodology. Continued "extensive" research on the "outcome" is incapable of producing such evidence. Rather it is producing a more complete picture of the "outcome" but which cannot prove the process behind such an outcome. Instead, an agglomeration is being identified and described. Subsequently, this agglomeration is being explained through the use of transaction costs theory. Finally, the fact of agglomeration is being used as evidence for the transaction costs theory of location. In the end, Scott is using as proof what he is trying to explain.

This investigation of the New Industrial Spaces thesis has revealed that its spatial mechanism of transaction costs represents a (theoretically) possible causal process of agglomeration. More importantly, however, this investigation has also shown that in many such cases this mechanism is unlikely to provide a satisfactory explanation, both in terms of the selective organisational change required to bring the mechanism into the field of play and exactly what conditions it will find on entering the field. Ultimately, the mechanism's relevance as an explanation of the agglomeration of production rests upon the empirical evidence for its operation. Unfortunately, such evidence has been found to be lacking, principally on the basis of what form such evidence must take to be eligible for adjudication. With this in mind, the following chapter outlines the research design adopted by this study in the quest to discover the causal process(es) driving the growth of Britain's premier high technology production agglomeration.

CHAPTER FIVE: The Empirical Exploration: What To Look at and How To Look At It

5.1 Introduction

The previous chapter outlined certain weaknesses of the New Industrial Spaces thesis and, most particularly, the limited empirical justification, so far, for this theory. Yet, if the theory is to be greeted as an advancement of our understanding within industrial geography, the need for further empirical evidence is great. More than mere "impressionistic" evidence of the theory's empirical relevance, above and beyond Silicon Valley and the Third Italy, involving more than identification of "new" agglomerations of production, is still required. Most especially, and as explained in Chapter Four, conclusive evidence of the New Industrial Spaces spatial logic, even within the *spaces par excellence*, is still elusive.

Thus, this chapter outlines how such an exploration for evidence of a high technology New Industrial Space within Britain was undertaken. An exploration structured by the foremost aim of providing empirical evidence of the causal processes (the spatial logic) driving the "space's" growth.

5.2 Why High Technology? In Britain?

As one of the three flexible industrial ensembles identified by Scott and Storper, earlier chapters have already signified both the structural and symbolic

importance of high technology industry to Britain's economic future. In Chapter Three the significance of the industry in relation to uneven development in Britain today was also highlighted. However, much of the work available on Britain's high technology, especially that carried out by journalists and promotional myth-makers, has particularly followed and promulgated the symbolism of high technology. Moreover, the work available has often uncritically encompassed theoretical notions and generalisations. So, for example, the concept and identification of a British "sunbelt" stems directly from the use of such stereotype terminology to describe aspects of the geography of high technology industry in the USA. Yet, as Pinch et al. (1989) argue, the use of notions such as "sunbelts" has involved:

> "...generalising from specific features of a particular society [USA]. In realist terms then, the 'sunbelt' concept might be thought of as a classic 'chaotic conception'." (op.cit.,p.6)

Today, the sunbelt notion is being engulfed by a new American import, the concept of the "New Industrial Spaces" (see, for example, Marshall,1989). Hence, Scott and Storper's work involves claims for several regions of Britain which they have proclaimed as British examples of the New Industrial Spaces (eg.M4 Corridor, Cambridge). This transfer of the New Industrial Spaces terminology to Britain, whilst re-invoking the concerns of Pinch et al. (1989) produced by the last theoretical import, simultaneously provides an investigative opportunity to strengthen the empirical weakness of the theory and our

knowledge of Britain's high technology success stories.

5.3 The Exploration of a British High Technology New Industrial Space

The starting point of any possible exploration is the identification of such a New Industrial Space. Scott (1988a) has identified two possible examples: a shortened M4 Corridor running from Reading to London; and Cambridge. However, by what process has he arrived at these particular "spaces"? How do you identify a (high technology) New Industrial Space?

Spotting a New Industrial Space: distinguishing characteristics

The steps of identification may be extracted from the example of Silicon Valley and other exemplary New Industrial Spaces discussed by Scott (1988b; see also Chapter Four). In summarised form, most fundamental to identification is the depiction of the growth of a (high technology) "flexible industrial ensemble" within a "space". Thus, in this particular instance, a preliminary requirement is to clarify exactly what industrial sectors would be included in a "high technology flexible industrial ensemble". What do Scott and Storper mean by "high technology" industry?

> "High technology industry is composed of a wide variety of different sectors of production. It includes, for example, pharmaceuticals, bioengineering, advanced metallurgical

industries, electronics, military and space hardware production, and so on. More often than not these sectors differ markedly from one another in terms of their physical constitution, employment characteristics, and outlets. They are unified by their common dependence (directly or indirectly) upon advanced scientific and engineering knowledge, and by their imbrication within capitalist relations of production"

(Scott and Storper,1986,p.1)

Moreover:

> "...the central <u>symptomatic</u> sector of the whole [high technology] complex is the electronics industry. This includes electronics in the narrow sense as well as electronics in the broader sense as represented by sets of sub-assemblies and fully-assembled systems (such as computers, communications equipment, guided missiles, space vehicles, and so on) in which electronic devices are the basic active components. Electronics is central because it provides the means of accomplishing work (above all measuring, calculating, controlling, and information processing) without the intermediation of mechanical aids."
>
> (Scott and Storper,1986,p.3,authors' emphasis)

Thus, the first stage of identification is to pinpoint those "spaces" experiencing significant growth of "high technology" industry. In particular, this growth must also be linked with the process of extension of the social division of labour. Subsequently, the "space" may then be analysed in the context of the economic geography of the industry as a whole. In other words, whilst high technology may be important to the space is the space important in

terms of the industry. Does the space represent a significant agglomeration of high technology industry?

These steps of identification pinpoint "probables" which are then likely to be confirmed by identification of particular agglomeration economies. Thus, further investigation of the agglomeration as a production network may be carried out or the possibility of specialised local labour markets and conducive socio-institutional structures (eg. "something in the air") explored. However, the conclusive step of identification, and one argued to be missing from Scott's empirical work and thus the list above, is the provision of evidence of the causal processes creating such agglomeration characteristics (see Chapter Four).

Possible sightings: Britain's high technology New Industrial Spaces

Thus it is through the above (or similar) steps of identification that the M4 Corridor and Cambridge have been pinpointed as examples of British high technology New Industrial Spaces by Scott (1988a). However, such identification has been hotly disputed by other commentators (Lovering,1990a; Rainnie et al.,1988):

> "Weakest of all is the evidence for the emergence of new marshallian industrial districts in the UK. The areas within the UK which have been cited by enthusiasts as 'new industrial spaces' are the M4 corridor and Cambridge (eg.,Scott,1988[a]; Sabel,1988; Mulgan,1989). But if there is any research which

demonstrates that these zones fit the description of a genuine industrial district (spatially agglomerated production complexes together with their dependent labour markets and intercalated human communities; Scott,1988[a];176), it has yet to be published (see for example, Morgan and Sayer,1988)."
(Lovering,1990a,p.167)

Lovering's comments, although rather forthright, do highlight the importance of debating, and not accepting, the labelling of these areas as New Industrial Spaces. Part of this debate may stem from disagreements about what the labels, such as "industrial district", actually mean (see Chapter Four and Amin and Robins,1989), yet, in contradiction to Lovering (1990a), Chapter Three included a quote from the (published) empirical work of Keeble and Kelly (1986) on Cambridge which possibly does sustain the view of the town as a "high technology industrial district" (see also Keeble,1989). However, in defence of Lovering, other work by Saxenian (1989) on Cambridge has refuted this analysis. Or rather it has suggested "Cambridge as industrial district" to be a short-lived phenomenon.[49]

The labelling of the M4 Corridor as a New Industrial Space is, however, more complicated and intriguing because it reveals the sheer persistence (and damage) of mythology. For there are actually two criticisms of this labelling that Lovering (1990a) could be making. Firstly, there is a

[49] In so doing, Saxenian's (1989) work highlights the argument of many that the "industrial districts" may well, in fact, not be the "end-state" form of post-Fordist industrial development but, rather, a temporary or transitional phenomenon of the move to post-Fordism (Amin and Robins,1989; Martinelli and Schoenberger,1989)

strong argument to be made for the banning of the term M4 Corridor as a highly misleading representation of the geography of Britain's premier high technology industrial agglomeration. Secondly, and the criticism being made, once the area of high technology agglomeration labelled the M4 Corridor has been properly identified, its characteristics are not those of a genuine "industrial district".

Chapter Three discussed the comprehensive work of Hall et al. (1987) which refuted the concept of an M4 Corridor. Or rather it severely curtailed the concept's geographical coverage but, in hindsight, should have renounced the term totally. For Hall et al. (1987) concluded by identifying:

> "...a Western Crescent, rather than a Western Corridor. Nevertheless, the biggest and fastest-growing concentration within this Crescent does lie to the west of London. Thus, we do have an M4 Corridor, but a short, concentrated one - focused on Berkshire and north Hampshire - superimposed on a Western Crescent of economic growth. The analysis presented here does *not* identify the long M4 Corridor - from west London to South Wales - that is popularly assumed." (op.cit.,p.5)

Similarly, in the work of Morgan and Sayer (1988) referred to by Lovering, the authors initially used the concept of an elongated (and widened?) M4 Corridor including Avon, Berkshire, North Hampshire, South Oxfordshire and North Wiltshire (op.cit.,Table 11.1). Subsequently, however, the authors also concluded that the notion of an M4 Corridor is misleading and argued that:

> "Berkshire has had the lion's share of the industry in the corridor and it is only here that it seems reasonable to speak of an electronics agglomeration." (Morgan and Sayer,1988,p.215)

By corroborating the work of Hall et al. (1987), it could have been expected that Morgan and Sayer's work would have seen the "jettisoning" of the term M4 Corridor once and for all. For Hall et al. (1987) outlined that the M4 Corridor did not exist precisely because, in reality, it represented little more than the county of Berkshire which happened to be bisected by the (new) M4 motorway[50]. Instead, the term has migrated overseas in a form that only partially acknowledges this work by defining the M4 Corridor New Industrial Space as running from Reading to London (Scott, 1988a).

In fact, what Hall et al.'s (1987) work additionally revealed is that if all of the county of Hampshire was analysed, rather than only the northern part of the county arbitrarily "inserted" into the M4 Corridor, Hampshire's high technology employment in 1981 was 33,807, nearly 15,000 more than that of Berkshire (although Berkshire had experienced a better recent growth rate, see Table 3.3,p.75). Moreover, the location quotient of employment concentration for Hampshire of 2.00 was almost identical to Berkshire's figure of 2.08 (see Table 3.2,p.74). Indeed, Hall et al. (1987) also found that in terms of absolute numbers of high technology workers employed and concentration of high technology employment, both these

[50]In fact, they also included north Hampshire in the shortened M4 Corridor yet, ironically, and highlighting the sheer inconsistency of the term, the M4 does not actually pass through the county at all.

counties were out-performed by Hertfordshire which could not possibly be associated with the M4 Corridor (see Table 3.2 and 3.3).

Thus, that is why Hall et al. (1987) concluded their study of high technology agglomeration in Britain by arguing for a Western Crescent running from Surrey through Hampshire and Berkshire into Hertfordshire. That is also why the continued use of the term M4 Corridor to describe Britain's premier high technology industrial agglomeration is both misleading and incorrect and why **labelling the M4 Corridor as a New Industrial Space is therefore also incorrect.**

However, if we accept this argument concerning the terminology (and rather vainly hope that the death-knell of the term M4 Corridor has been sounded), it is not unreasonable to presume that the area Scott really implies by a shortened M4 Corridor is, most particularly, Berkshire. It is clear that Berkshire is a leading high technology county of Britain and hence the labelling of this county as a New Industrial Space may have some justification. Indeed, using an interpretation of Morgan and Sayer's (1988) work somewhat at odds with Lovering's, evidence may be available:

> "[Berkshire] is quite different both qualitatively and quantitatively from leading American agglomerations like Silicon Valley and Orange County in California, each with over 200,000 electronics employees...[and although] there have been spin-offs in the corridor their success has been limited. At

the same time, Berkshire includes much less manufacturing in electronics - particularly in recent foreign entrants - than is found in the American agglomerations. This probably accounts for the fact that while local inter-firm linkages are much more common than in South Wales (thanks largely to the prevalence of less routinized activities in the corridor) they do not compare with the dense networks of linkages characteristic of Silicon Valley and Orange County (Scott and Angel,1986; Scott, 1986b; Glasmeier,1986).

Generally, the electronics agglomeration emerging in Berkshire appears to cohere more on the basis of its local labour market for top technical and managerial skills than on inter-firm linkages." (Morgan and Sayer,1988,p.215-6)

Thus, there is a certain amount of ambiguity concerning the possibility of Berkshire as a New Industrial Space. For whilst Berkshire represents a leading high technology production agglomeration, including an above-average proportion of new and small firms, Morgan and Sayer (1988) question its cohesion as a **localized production complex**. The complex seemingly does not cohere directly through inter-firm linkages and thus the existence of the New Industrial Spaces spatial logic, founded upon inter-firm network production organisation, is dubious. Yet seen as an increasingly important component of that spatial logic is the role of local labour markets (Chapter Four; Scott,1990, personal communication), and Morgan and Sayer (1988) do raise the possibility of "indirect" coherence of the agglomeration based upon a specialist local labour market. Moreover, their research on the county revealed the awareness of this labour market by employers and,

critically, the importance of this factor in **locational decision-making**. And it is this aspect of empirical evidence, evidence of the theorised New Industrial Spaces spatial logic, which Chapter Four has argued as critical in any conclusive identification of a New Industrial Space and yet is sparse even within those "exemplary spaces" such as Silicon Valley.

However, leaving the possibilities of Berkshire *per se* aside, it must be remembered that the county is actually only one high technology county within a series of South Eastern counties comprising, **not** the M4 Corridor but rather, the high technology industrial agglomeration known as the Western Crescent. Moreover, within this agglomeration it is arguably the (neglected) county of Hertfordshire which leads the way.

Table 3.3 (p.75) reveals that in 1981, after Greater London, Hertfordshire had the greatest number of high technology workers of any county in Britain, totalling over 45,000. This easily doubled the high technology employment figure for Berkshire and, furthermore, this also represented a greater concentration of high technology employment than that found in Berkshire. In fact, Hertfordshire's location quotient of 3.60 placed it clearly at the head of a league table of British counties in which Berkshire came fifth with a figure of 2.08 (Table 3.2,p.74). Moreover, Figures 3.1 (p.78) and 3.2 (p.79) reveal continued (modest) growth of the county's high technology employment. Thus, whilst much attention has been focussed upon the county of Berkshire as the core county of

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a largely illusory M4 Corridor (see for example Hall et al.,1987; Macgregor et al.,1986; Morgan and Sayer,1988), it would seem that the impressive growth of high technology industry in Hertfordshire has gone largely unnoticed by industrial geographers within Britain, let alone across the Atlantic. If we are to identify a high technology New Industrial Space within Britain, the county of Hertfordshire, as part of the wider Western Crescent agglomeration, presents itself as an outstanding candidate.

5.4 The Plan of Exploration of "High Technology Hertfordshire"

The initial stage of the exploration will involve the comparison of Hertfordshire *vis-a-vis* the New Industrial Spaces model, in a similar fashion to that adopted by Scott (see earlier, this chapter). Essentially, the question is: does the candidature of "high technology Hertfordshire as New Industrial Space" represent a fair test of the theory. What "distinguishing characteristics" common to both Hertfordshire and the model enable the county to be viewed as a possible example of a New Industrial Space?

Thus, initially, the industrial history of Hertfordshire will be traced which has led to the county's depiction as part of the Western Crescent high technology agglomeration. This will be undertaken through the use of secondary sources but, also, a postal questionnaire scan, to reveal both the present status of high technology industry within the county and further historical evidence of the ensemble's development. Furthermore, evidence of those

other agglomeration characteristics associated with the New Industrial Spaces, such as specialist local labour markets and unique and advantageous "industrial atmospheres", will be sought.

However, following on from the methodological critique put forward in Chapter Four, it must be recognised that this exploratory stage merely allows the descriptive compatibility of the Hertfordshire agglomeration's characteristics and those of the New Industrial Spaces agglomeration model to be gauged. Fundamentally, it does not provide evidence of the causal dynamic(s) creating those (agglomeration) characteristics. It does not, and cannot, provide evidence of the spatial logic(s) driving the agglomeration. Yet it has already been outlined how it is this common causal logic which is, ultimately, the **definitional bond** of the disparate regions classified as New Industrial Spaces.

Providing evidence of a (pattern of) local production network, local labour market or industrial atmosphere is not enough. Evidence must be provided of these components **operating as a spatial logic driving the agglomeration** such as, for example, firms being drawn into the county (or being unable to leave?) because "this is where it's at" or to tap a scarce and critical labour source. Most particularly, evidence must also be sought of the critical and foremost dynamic of the New Industrial Spaces (and the dynamic upon which this exploration will concentrate). In other words, evidence of a particular form of industrial organisation, a local production network,

creating a "centripetal" force of location as firms seek to reduce transaction costs through "convergence around their own geographical centre of gravity" (see Scott,1988a; quoted in Chapter Four).

In the search for this critical empirical evidence the questionnaire will provide evidence of "outcomes". Viewed most simply, such outcomes are "high technology firms agglomerated within Hertfordshire". But, as we know from Chapter Four, such outcomes may or may not be commensurate with those outcomes theorised as exemplary of a New Industrial Space and its causal mechanisms. However, the questionnaire will significantly strengthen the empirical work thus far carried out by Scott. For it will **also** be able to identify those **particular** outcomes suggested as evidence for the workings of the causal mechanism, namely those establishments located in the region who stipulate that **local production linkages were significant in their location decision.** In other words, the questionnaire will identify particular outcomes representing a process of cause and effect commensurate with that hypothesised by the New Industrial Spaces thesis.

As was explained in Chapter Four, Scott has failed to ask the (fundamental) question as to whether or not local production linkages have played a role in the location decisions of individual establishments. Rather, his own empirical work has identified agglomerations of establishments and (more recently) linkages between such agglomerated sites. He has subsequently assumed that such

sites are located because of such linkages. In other words, he has assumed that all establishments in agglomerations with local production linkages are "outcomes" of the New Industrial Spaces spatial logic. However, this must be recognised for what it is, an assumption, and to overcome this the postal questionnaire will ask a question concerning the role of local production linkages in location. Hence, a sub-set of particular outcomes, "establishments whose local production linkages played a significant role in location" rather than a set of outcomes "all establishments with local linkages (which thus played a role in location)" will be distinguished.[51]

But, even if this more stringent identification of outcomes is achieved by the postal questionnaire, it cannot, by itself, prove the causal mechanism of these outcomes. **For it merely indicates a process of cause and effect, it does not say what mechanism drives this process.** This, as we have seen, is the further assumption of the model. For although it is known that such outcomes are due to a process based on local production linkages, the nature (mechanism) of this process (ie.how it works) is not yet known. Rather the assumption is made that such outcomes are due to a particular (theorised) causal mechanism of "transaction costs". In fact, the nature of the causal process is yet to be discovered and, moreover, a second stage of exploration is required to make this discovery. This second stage of the exploration will involve semi-structured interviewing of chosen "case study" firms.[52]

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[51] That is, if such outcomes do exist empirically rather than just theoretically.

[52] The "study of individual agents in their causal contexts" (Sayer,1984,p.222). In other words, the study of establishments within an agglomeration network.

Thus, the plan of exploration involves a long range scan by postal questionnaire and gathering of secondary data followed by a "landing" to carry out a series of case-study interviews. The use of such a two-stage design significantly strengthens (methodologically) that empirical exploration thus far undertaken of the New Industrial Spaces. For, firstly, it provides precise identification of outcomes, that is, effects of a particular process and, secondly, it allows exploration of the **nature** of the process producing such outcomes.

5.5 The Long Range Scan

As outlined above, this stage involved two exploratory techniques. On the one hand, it embodied the collation of evidence from other explorations of the region. On the other hand, it involved the direct sourcing of data through the use of a postal questionnaire survey.

The postal questionnaire survey

It may be recalled that this element of the exploration had two major aims. Firstly, to gain a snapshot of the present agglomeration of high technology industry in Hertfordshire as the most recent period in the industrial history of the county. Secondly, to identify the existence of a causal process to this contemporary agglomeration, in preparation for further investigation of the causal process through a series of case studies.

The creation of a firm listing

The initial problem to be faced was that of gaining a comprehensive listing of high technology firms in Hertfordshire to scan. Particular requirements were that the listing distinguish establishments, rather than firms *per se*, on the basis of a S.I.C. code for each entry. Despite the problems with the S.I.C. system discussed in Chapter 2, it is still the best (if not the only) classification system avilable providing the level of coverage required.

A variety of possible sources for a comprehensive listing were investigated such as company registrations, VAT registrations, County Council lists, Chambers of Commerce member lists, trade directories, telephone directories, etc. All of these had both strengths and weaknesses but it became clear that none of these sources alone could provide a comprehensive listing of high technology firms in Hertfordshire. Their combination, although difficult due to the variety of sources of base information, could possibly have allowed the construction of some form of list. However, in the course of carrying out such initial enquiries an organisation called HERTIS (Hertfordshire Information Services) was discovered, which provided the listing on which the survey was eventually based.

Hertis[53]

Hertis was set up approximately 30 years ago as a

[53] Information taken from an interview with Vivienne Winterman, Hertis.

federation of all the public libraries, further education libraries and other public information service organisations in Hertfordshire. It provides an information service free to any person or business in Hertfordshire and is funded by the County Education Department. In addition, it contains specialist departments such as the Information for Industry Unit situated at Hatfield Polytechnic. This unit receives a small grant to provide a free service to Hertfordshire's population but otherwise is a self-financing unit. In essence, it provides specialist information searching and retrieval for over 350 subscribing members (firms) as well as undertaking one-off contracts. Some of its services are based on providing information from the Hertfordshire Business Databank which it set up almost 10 years ago, and it is from this databank that the firm listing was drawn.

The Hertfordshire Business Databank

At the time of finding the Databank it listed more than 3,500 Hertfordshire businesses, classified by S.I.C. code, providing the name of a contact person (generally the chief executive, managing director or person of equivalent rank) and address of the establishment. Additional information on some establishments such as year in which trading began in Hertfordshire, employment numbers and turnover figures was also available. However, immediately prior to gaining a list of firms from the organisation, the Databank was "updated" through an agreement with Dun and Bradstreet (an international business information organisation), whereby a merging of the two organisations' data led to the

significant expansion of the Databank to include over 12,000 firms. This raised certain issues for the exploration.

Firstly, this highlighted that the original coverage of the Databank was in fact poor. However, following the update, Hertis believed the coverage to be between 60-65% with almost total coverage of limited companies. They had no knowledge of whether this coverage varied across industrial sectors, although it could be reasoned that certain sectors (eg.mature, high cost entry) would have a higher coverage due to the likelihood of a higher percentage of limited companies. This partial coverage must be acknowledged but, in the face of the variety of other possible sources providing equally partial coverage, the Database still ranked as the best information source available at the time.[54]

Secondly, problems arose with the data provided by the Databank immediately following its updating. This was due to the operational difficulties of merging two databases. For example, certain sectors saw a massive expansion in the firm population. For my purposes, and of great importance to the research, this either suggested that these sectors

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[54] Hertfordshire County Council has in previous years carried out a census of all firms located on designated industrial estates. Such information has been published and, in the past, added to the Hertfordshire Databank. Recently, however, the Council has taken a position of acting as a rival to the now "private" Databank providing its own listing and information service. In 1989-1990, the Council also undertook a census of all business activity within urban areas, the aim being to combine the results of this survey with those from the industrial estates census to produce a comprehensive listing of industrial activity in Hertfordshire (over 90% coverage was the figure quoted). Unfortunately, this information will be available too late for my research.

had seen spectacular growth rates or, as proved to be the case, this "growth" was due to increased coverage. In contrast, other sectors saw a reduction in their firm population. Again the question arose as to whether this was due to a process of "restructuring" leading to closure of establishments or the reclassification of firms into different sectors rather than firm deaths. Further explanation of these contradictions by Hertis made clear that reclassification was indeed the major cause, although a few firm deaths had taken place. Finally, there was the possible problem due to Dun and Bradstreet being an international company. In view of this fact, when dealing with multi-site firms would their information include dates and employment figures for individual **sites** in Hertfordshire as against whole firms? The answer was that, in the main, figures would be for the company as a whole. However, in certain instances where several individual sites for a company were separately listed then figures would be based on sites and not whole firms. In view of the importance of delineating between single-site and multi-site firms, the postal questionnaire addressed this information gap within the listing (see later).

Thus, in July 1989, Hertis provided a listing of establishments within Hertfordshire within a chosen set of 1980 S.I.C. Activity Headings (Table 5.1).

The Choice of "High Technology" Sectors

The choice of sectors (see Table 5.1) followed the definition of "high technology" put forward by Scott and

Storper (1986) (pp.216-7). In particular, the decision was taken to concentrate on "electronics" (in its widest sense) viewed by Scott and Storper as the "central" and "symptomatic" industry of the "high technology ensemble". Moreover, this selection of sectors also incorporated those electronics sectors which Hall et al. (1987) identified as forming the agglomeration of the Western Crescent but, in addition, the choice included computer services, a sector not recognised within the figures used by Hall et al. (1987), but now viewed as an essential and integral sector of the high technology ensemble.

TABLE 5.1 The high technology sectors under exploration

Activity Heading	Description
3302	Computers and electronic data processing equipment manufacture
3441	Telephone and telegraph equipment manufacture
3442	Electronic instruments and control systems manufacture
3443	Radio and electronic goods manufacture
3444	Electronic equipment (passive) components manufacture
3453	Electronic equipment (active) components and electronic consumer goods accessories
3640	Aerospace equipment manufacture
8394	Computer services

Initial examination of the listing raised several important issues. Firstly, some establishments were listed with more than one S.I.C. code. In other words, if the establishment

was engaged in activities and products encompassing more than one S.I.C code this was listed. This is in comparison to government statistics, for example, which classify each establishment by **major activity** only. As was explained in Chapter Two, this is a weakness of the S.I.C. system for not all persons on the site may be directly involved in this major activity, but the assumption made is that this is the only activity taking place at that site.[55]

Concerning the listing, an establishment was included if **any activity** carried out on that site came under one of the selected Activity Headings. Hence, in the cases where establishments were assigned more than one classification code, a similar assumption to that in government statistics was made that this activity was the major activity on the site. What this assumption entails can be exhibited by the use of an example. One establishment was coded 8394 (Computer services) and 6190 (Other wholesale distribution including general wholesalers). The firm is, in fact, a computer software bureau and computer stationery wholesalers. The activity 6190 is not, however, viewed as a high technology activity but rather a distribution activity. The firm is included in the listing because of its computer software activity. But the listing does not reveal what the percentage split between the two activities

[55]A favoured example of such a problem is administration departments linked to manufacturing plants, say biscuit production. Recent examples of "new" firms highlight that they have been created from the "externalisation" of such administrative functions by manufacturing companies. These jobs are classified within a different (service) sector but are, in effect, a transfer of jobs previously classified under "biscuit production". Howells (1987), for example, has identified how two of Western Europe's largest computer service companies were previously the internal computing bureaux of two large industrial concerns.

is within the establishment. In other words, it could be 75% software, 25% wholesale or 75% wholesale and 25% software.

A further aspect of the listing arose where establishments were engaged in more than one of the high technology activities identified. The establishment was listed under whichever Activity Heading was requested first, in this case, the numerically lower number. So, for example, where an establishment was engaged in Electronic Data Processing (3302) and Computer Services (8394) it would be listed under the former. This aspect, along with the previous point, must be borne in mind where analysis of results by individual sector takes place. However, such analysis is not prevalent for, as has been emphasised throughout, the importance of the sectors individually lies in their being constituent of a "high technology ensemble", an inter-sectoral complex of firms engaged (and linked?) in some aspect of high technology production. Hence, in the case of the firm above engaged in computer services and computer stationery wholesaling, the latter activity may well constitute an important aspect of the high technology complex as a whole without, strictly speaking, such an activity ever being defined as high technology.

The Survey Sample

The listing provided the names and addresses of 578 establishments. Further investigation revealed that a small percentage of entries were duplicated (4%) and these were removed leaving a remaining 554 entries. The distribution

of establishments between Activity Headings may be seen in Table 5.2.

TABLE 5.2 Numbers of establishments by Activity Heading within the firm listing

Activity Heading	Description	No. of Estab.
3302	Computers and electronic data processing equipment manufacture	64
3441	Telephone and telegraph equipment manufacture	21
3442	Electronic instruments and control systems manufacture	19
3443	Radio and electronic goods manufacture	57
3444	Electronic equipment (passive) components manufacture	13
3453	Electronic equipment (active) components and electronic consumer goods accessories	37
3640	Aerospace equipment manufacture	17
8394	Computer services	326
	TOTAL	**554**

Clearly the most striking feature of this distribution was the dominance of the Computer Services sector which outnumbered all of the other manufacturing sectors put together. Also, the establishment total of 554 was of such a size that it precluded a 100% survey, on the grounds of time and money, hence it was decided to survey a numerically manageable sample of the establishments listed.

Two possible alternative logics seemed immediately to

present themselves as to how to choose the sample. Firstly, a random 50% sample of all sectors could be taken so a total of 277 establishments would be sampled (or a 60% sample and 332 firms). The major drawback of this alternative, however, was that samples of certain sectors would involve small numbers, even less than 10 in some circumstances. If a low response rate then occurred only a couple of questionnaire returns would possibly be achieved from a particular sector. In other words, the smallness of certain sectors would be turned into a disadvantage when in fact such smallness could be seen as advantageous. For a 100% survey of such sectors, a practically possible alternative, would allow for the possibility of the whole sectoral picture to be discovered (allowing for partial coverage and non-response).

Hence, this led to the second possibility, and the alternative that was taken, which was to undertake a 100% survey of all the "small" sectors. As can be seen from Table 5.2 all the sectors, bar Computer Services (8394), had 70 or less establishments within them. Thus a complete 100% survey of all these sectors involved surveying only 228 establishments. This could then be combined with a sample, say 30% (98 establishments), taken from the computer services sector to achieve a (barely!) manageable sample of 326 establishments. Although this alternative was taken it is, however, open to the criticism that once again manufacturing is being "prioritised" over services. Yet the fact that Computer Services was included in the initial choice of high technology sectors represented an advance on

previous work undertaken on high technology. Moreover, the sector still represented the largest sector to be surveyed numbering almost 100 establishments.

The Survey Questionnaire

Earlier discussion has revealed that the questionnaire was to act as the first stage in a two-stage exploration and its form was accordingly shaped by this methodology. The questionnaire's first essential aim was to provide a "snapshot" of high technology establishments in Hertfordshire and their firm characteristics, especially those characteristics previously theorised as central to the locational process. As outlined in Chapter Four, ownership linkages and their spatial form were highlighted as a particular characteristic which to some extent had been ignored in the previous work of Scott.

The second aim was to discover the reasons for these sites' location within Hertfordshire and hence identify, or at least "signpost", the locational processes at play. In particular, in following the essential locational logic argued for within the theory of the New Industrial Spaces, the questionnaire aimed to address the question of whether or not production linkages had played a role in the location decision of individual establishments. In respect of this aim, the initial identification of the locational process would then be expanded through the second stage of exploration involving follow-up interviews designed to investigate, in greater depth, the identified process of location.

As such then, the questionnaire was about surveying a large group of sites to gain basic information. Hence, the questionnaire was deliberately kept to a minimum length with the hope of gaining an increased response rate in return, a hope which was realised with a 69% response rate being achieved. The questionnaire was piloted and, indeed, this stage taken to experiment with the exact format of particularly crucial questions.

From looking at Figure 5.1. (P.Quest. Pilot 1), it can be seen that the questionnaire opens by splitting respondents by **"ownership linkage"** between a <u>"branches/subsidiaries"</u> group and an <u>"independents"</u> group, the latter group being directed on to Question 2. Question 1 then further investigates the ownership linkage of the establishments within the branches/subsidiaries group, as well as gathering **"characteristics"** information such as date when trading began in Hertfordshire and the spatial structure of the firm <u>within Hertfordshire</u>. Where a spatial structure internal to the county exists (ie. more than one site), the question finishes by asking if **"production linkages"** occurred between these different sites and, most crucially, whether such linkages have played a role in the **locational decision** of the site. Question 1, then, immediately splits sites by ownership linkage, an important aspect overlooked by Scott, and attempts to investigate if the locational logic ascribed by Scott as occurring between firms is actually present <u>within firms</u> as well.

Question 2 partly performs a similar function to that of Question 1, but for establishments within the

FIGURE 5:1

Postal questionnaire pilot 1

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HERTFORDSHIRE ESTABLISHMENTS QUESTIONNAIRE

1) Are you a branch or subsidiary? ..... YES/NO (If no,go to 2)
Please name your parent company .....
Where is your HQ sited? .....

What year did this branch/subsidiary start trading in Hertfordshire? .....

Are there any other of your company's branches within Hertfordshire? YES/NO

Do you have a strong customer/supplier linkage (including subcontracting) or any other strong linkage with any of these branches? (Please state what sort of linkage and with whom)
.....
.....
.....
.....
.....
.....

Were any of these linkages important to the location of your establishment in Hertfordshire? Please state which linkages.
.....
.....
..... (Go to 3)

2) As an independent company do you own/part own any other companies:
..... in Hertfordshire YES/NO .....outside of Hertfordshire YES/NO

Please name those companies .....

When did your company start trading in Hertfordshire? .....

3) What are the main functions carried out within your establishment? (please tick):
- HQ ☐
- Production of a direct product/service[1] (1 Delete as applicable) ☐
- Research and Development for your direct product/service[1] ☐
- Design for your direct product/service[1] ☐
- Marketing for your direct product/service[1] ☐
- All the functions listed above ☐
- Other (please specify) .....

4) Is your largest supplier (including subcontracting) located within Hertfordshire? Y/N

If yes please name this company.....

Is your second largest supplier (including subcontracting) located within Herts? Y/N

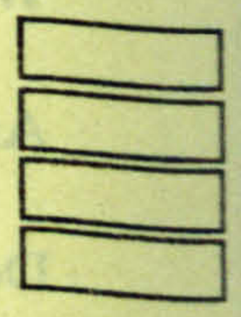
Is your largest customer located within Hertfordshire? Y/N

If yes,please name this company.....

Is your second largest customer located within Hertfordshire? Y/N

5) How important were these linkages to your establishment's decision to locate in Hertfordshire?

- Very important
- Important
- Unimportant
- Not important at all



6) Could you briefly list what were the most important factors to your establishment's decision to locate in Hertfordshire?

.....

.....

.....

.....

.....

END

Once again I thank you for taking the time to complete this questionnaire.

A prepaid addressed envelope is attached for its return.

"independents" group. It investigates this group's **ownership** as well as gaining information as to the **characteristics** of the establishments.

Question 3, where both groups "join" once again to complete the remainder of the questionnaire, continues the investigation of the **characteristics** of the sites by asking what functions are carried out on each site.

Question 4 moves on to investigate in greater detail the **production linkages** of each site, asking for the names and location of each establishment's largest suppliers and customers.[56] Given the likely sensitivity of respondents to answer a question which provides commercial information of this nature, two alternative forms of the question were devised and piloted (compare Figure 5.1 and 5.2 [P. Quest. Pilot 2]). As can be seen in Figure 5.1, Question 4 provides the essential information as to whether or not production linkages occur internally or externally to Hertfordshire, but maintains an element of anonymity as to exactly who these linkages are with. In contrast, the alternative Question 4 in Figure 5.2 provides greater information in identifying exactly where, and with whom, production linkages are situated, whether internal or external to the county.

Question 5 is the question which it is argued has not yet

[56] "Largest" production linkages were identified so as to follow Scott's most recent work on Southern California (Scott,1989; Scott and Mattingly,1989; Scott and Drayse, forthcoming). However, it will be seen that Question 6 of the questionnaire allowed for other (ie. not the largest) production linkages to be listed if the respondent viewed them as significant in their location decision.

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Nicholas Henry

FIGURE 5.2: Postal questionnaire pilot 2

HERTFORDSHIRE ESTABLISHMENTS QUESTIONNAIRE

1) Are you a branch or subsidiary? ..... YES/NO (If no,go to 2)
Please name your parent company .....
Where is your HQ sited? .....

What year did this branch/subsidiary start trading in Hertfordshire? .....

Are there any other of your company's branches within Hertfordshire? YES/NO

Do you have a strong customer/supplier linkage (including subcontracting) or any other strong linkage with any of these branches? (Please state what sort of linkage and with whom)
.....
.....
.....
.....
.....

Were any of these linkages important to the location of your establishment in Hertfordshire? Please state which linkages.
.....
.....
..... (Go to 3)

2) As an independent company do you own/part own any other companies:
..... in Hertfordshire YES/NO .....outside of Hertfordshire YES/NO

Please name those companies .....

When did your company start trading in Hertfordshire? .....

3) What are the main functions carried out within your establishment? (please tick):
- HQ ☐
- Production of a direct product/service[1] (1 Delete as applicable) ☐
- Research and Development for your direct product/service[1] ☐
- Design for your direct product/service[1] ☐
- Marketing for your direct product/service[1] ☐
- All the functions listed above ☐
- Other (please specify) .....

4) Please give the name and town location of your two largest suppliers (including subcontracting) eg. Henry's Electronics, Milton Keynes

.....

.....

Please give the name and town location of your two largest customers.

.....

.....

5) How important were these linkages to your establishment's decision to locate in Hertfordshire?

- Very important ☐
- Important ☐
- Unimportant ☐
- Not important at all ☐

6) Could you briefly list what were the most important factors to your establishment's decision to locate in Hertfordshire?

.....

.....

.....

.....

END

Once again I thank you for taking the time to complete this questionnaire.

A prepaid addressed envelope is attached for its return.

been asked by Scott, to the detriment of his empirical work on the New Industrial Spaces. Once establishments have provided information on their production linkages from the previous question, establishments are asked to indicate exactly how important these linkages were in their **locational decision**. Question 5 explicitly identifies a particular "location factor", a factor representing what is argued is the locational dynamic to the New Industrial Spaces, and prompts a response as to the importance of this factor to the establishment's location.

In contrast, Question 6 is a deliberate "catch-all" question concerning the **location decision** of the establishment. It simply asks respondents to identify, without prompting, what were the factors in their location decision. Hence, in one aspect it acts as a back-up to Question 5 allowing further confirmation, and expansion, of expressions made in the previous question. However, it also allows for the possibility of other location processes to be identified, including those other "agglomeration" factors prioritised within the New Industrial Spaces thesis.

The Pilot Survey

An initial pilot sample of 59 establishments was chosen which represented the same proportion of establishment "types" as found in the listing. For example, establishments were firstly chosen on the basis of sectoral coverage and size, further combined with independent or

multi-site status (where known), date of firm birth (where known) and "industry leader" status (where known).

An equal mix of questionnaires with the alternative forms of Question 4 were sent out in August 1989, accompanied by a covering letter (Figure 5.3) and a pre-paid self-addressed envelope. Reminder letters were sent in early September (Figure 5.4) and follow-up phone calls made to those non-respondents still outstanding after the reminder letter had been sent. A response rate of 77%, representing 36 returns, was achieved for the pilot survey, broken down as in Table 5.3.

TABLE 5.3 Response statistics for the pilot survey

	No.	%
SAMPLE	59	(100)
RESPONSES	36	(77)
NON-RES.	11	(23)
'GONE AWAYS'	12	(20)

These figures split as a 78% response rate from manufacturing sectors (sample = 40), representing 25 returns, and a 73% response rate for the service sector (sample = 19), representing 11 responses. The "gone away" figure for manufacturing of 20% compared with a similar figure of 21% for services.

Hence, the pilot questionnaire was successful. It gained a high response rate, both in total and for rates to individual questions whose response rates matched those for

FIGURE 5.3 : COVERING LETTER

The Open University
Walton Hall
Milton Keynes
MK7 6AA

Telephone (0908) 274066

Direct Line (0908) 65
Telex 825061
Fax (0908) 653744

Faculty of Social Sciences

August 1989

Dear

I am a researcher in the Urban and Regional Research Group based at the Open University, Milton Keynes. The area of my research concerns why high technology firms are located, and are continuing to locate, within Hertfordshire. In particular, I am interested in the production and ownership linkages establishments have with each other, especially within Hertfordshire.

The results of the short questionnaire attached will be combined with interviews with a selection of firms and interested bodies such as the Chamber of Commerce and local authorities, to gain a view of the local support networks for high technology industry in Hertfordshire and their role in location.

I am aware of the constraints on your time and the importance of such time and therefore, have kept the questionnaire to a very short and simple double-sided page.

I would be extremely grateful if you would participate in this research project by completing the questionnaire and returning it in the pre-paid envelope. I should emphasise that YOUR REPLIES WILL BE TREATED IN THE **STRICTEST CONFIDENCE** AND YOUR ANONYMITY MAINTAINED IN ANY SUBSEQUENT PUBLISHED RESULTS.

Yours sincerely

Mr. Nicholas Henry

FIGURE 5.4 : REMINDER LETTER

The Open University

Faculty of Social Sciences

The Open University
Walton Hall
Milton Keynes
MK7 6AA

Telephone (0908) 274066
Direct Line (0908) 65
Telex 825061
Fax (0908) 653744

September 1989

Dear

I sent you a questionnaire in mid-August. The majority of these questionnaires have now been returned but I unfortunately do not seem to have received a reply from yourself.

Presuming that my questionnaire arrived, I am aware that it may well have been put aside for more immediately urgent matters or indeed, if lucky, until your return from holiday!
However, I write to ask that you now take the five minutes, all that is required, to complete the questionnaire and return it to me in the envelope provided.

The responses so far have been of immense interest and I eagerly await those few still outstanding.

Once again I remind you that **strict confidentiality will be maintained.** I would also like to stress my hope that, in time, the results of this research will be of use to you and other companies located in Hertfordshire.

Yours sincerely

Mr. Nicholas Henry

the questionnaire as a whole. Following on from the successful response rate the two versions of Question 4 elicited similar response rates, yet the second alternative provided greater information and thus was chosen for use in the main survey. A further sub-question was also added to the main survey questionnaire concerning the numbers employed by each establishment. The initial listing had provided incomplete data on employment numbers and responses to the date of birth question suggested some inaccuracies within the listing concerning this information. Hence, in the light of the good response rate, and the additional question adding minimally to the length of the questionnaire, it was included in the main survey. Minor design alterations were also made to the questionnaire format to produce the questionnaire used in the main survey (Figure 5.5).

An issue of concern from the pilot survey was, however, the "gone-away" figure encountered, with 20% of those establishments sent questionnaires no longer in business at that site for one reason or another. In fact, the range of explanations as to the categorising of establishments as "gone away" is itself of interest in highlighting the variety of processes of economic development within any local economy (see later, this chapter). In a context whereby only a 30% sample of the Computer Services sector was to be surveyed in the first place, it was felt that to then have the possible number of respondents reduced by a further 20% due to "gone-aways" was unsatisfactory. Hence, the decision was taken to try and identify, in advance, any

FIGURE 5.5: Postal questionnaire, main survey

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Nicholas Henry

HERTFORDSHIRE ESTABLISHMENTS QUESTIONNAIRE

1) Are you a branch or subsidiary? YES/NO (If no,go to 2)

Please name your parent company .....

Where is your HQ sited? .....

What year did this branch/subsidiary start trading in Hertfordshire? .....

How many people are employed in this branch / subsidiary? .....

Are there any other of your company's branches within Hertfordshire? YES/NO

Do you have a strong customer/supplier linkage (including subcontracting) or any other strong linkage with any of these branches? (Please state what sort of linkage and with whom)

.....

.....

.....

Were any of these linkages important to the location of your establishment in Hertfordshire? Please state which linkages.

.....

.....

..... (Go to 3)

2) As an independent company do you own/part own any other companies:
- in Hertfordshire YES/NO - outside of Hertfordshire YES/NO

Please name those companies .....

.....

When did your company start trading in Hertfordshire? .....

How many people do you employ in your company? .....

3) What are the main functions carried out within your establishment? (please tick):

- HQ ☐
- Production of a direct product/service[1] ☐
- Research and Development for your direct product/service[1] ☐
- Design for your direct product/service[1] ☐
- Marketing for your direct product/service[1] ☐
- All the functions listed above ☐
- Other (please specify) .....

(1 Delete as applicable)

PTO

"gone-away" establishments. Telephone directories, directory enquiries and telephone calls where required were used in order to achieve this. The result was that 53 establishments were identified and removed from the listing as "gone-aways" prior to the main survey.

Finally, two questionnaires were initially returned uncompleted with the establishments concerned suggesting that they were not "high technology". The questionnaires were re-sent with an additional question asking what products were made on site and which industry did the establishment believe it was engaged in. One questionnaire was subsequently returned indicating that the establishment was involved in an activity classified under the Activity Headings pre-selected as "high technology", even though the respondent did not personally believe the high technology "status" accorded to *his* establishment. This instance would seem to exemplify one of the problems of the S.I.C. system discussed in Chapter Two, whereby not all firms within a high technology sector are necessarily involved in a high technology production process.

The Main Survey

This stage of the survey was undertaken at the end of October 1989. The pilot survey had previously indicated that reminder letters produced little additional response and, hence, follow-up phone calls were made

instead approximately 3 weeks after the questionnaire was sent. If necessary, the questionnaire was re-sent following these calls and in these cases a further follow-up phone call made if required.

After the removal from the initial listing of duplicated entries, 19 "gone aways" identified in advance, and excluding the 40 establishments already sampled, questionnaires were sent out to the remaining 169 establishments listed within the manufacturing sectors. For Computer Services, the removal of duplicated entries left 326 entries. A 30% sample amounted to a sample of 98 establishments. With 19 establishments already having been sampled in the pilot this left a main survey of a further 79 establishments. A Computer Services sample was chosen - after 34 pre-identified "gone aways" had been removed - which generally reflected the sector's listing as a whole in terms of size and age of establishment. Included in this were 5 particular firms especially chosen due to their being "leading" names in the sector or where results from the pilot sample had indicated their linkage in some form to an establishment already surveyed. Tables 5.4. (a), (b) and (c) outline the return statistics for the main postal survey and Tables 5.5. (a), (b) and (c) for the main and pilot survey statistics combined.

TABLE 5.4 Response statistics for the main survey

(a) Manufacturing Establishments

	No.	%
SAMPLE	169	(100)
RESPONSES	89	(63)
*NON-RES.	52	(37)
'GONE-AWAY'	28	(17)

* Includes 1 refusal

NB. It should be noted that the "gone-away" figure is low because of the removal of 19 entries identified as "gone-away" previous to the posting. The inclusion of these 19 entries gives the true "gone-away" figure of 25%.

(b) Service Establishments

	No.	%
SAMPLE	79	(100)
RESPONSES	52	(76)
NON-RESP.	16	(24)
'GONE-AWAY'	11	(14)

NB. Again, it should be noted that the percentage figure for "gone-away" is low as 34 known "gone-away" entries were removed prior to the posting.

(c) All Establishments

	No.	%
SAMPLE	248	(100)
RESPONSES	140	(67)
*NON-RESP.	69	(33)
'GONE-AWAY'	39	(16)

* Includes 1 refusal

NB. It should be noted that the percentage figure for "gone-away" is low as 53 known "gone-away" entries were removed prior to the posting.

TABLE 5.5 Response statistics for the complete survey (main and pilot combined)

(a) Manufacturing Establishments

	No.	%
SAMPLE	209	(100)
RESPONSES	114	(66)
*NON-RESP.	59	(34)
'GONE-AWAY'	36	(17)

* Includes 1 refusal

NB. It should be noted that the "gone-away" figure is low because of the removal of 19 entries identified as "gone-away" previous to the posting. The inclusion of these 19 entries gives a true "gone-away" figure of 24%.

(b) Service Establishments

	No.	%
SAMPLE	98	(100)
RESPONSES	63	(76)
NON-RESP.	20	(24)
'GONE-AWAY'	15	(15)

NB. Again, it should be noted that the percentage figure for "gone-away" is low as 34 known "gone-away" entries were removed prior to the posting.

(c) All Establishments

	No.	%
SAMPLE	307	(100)
RESPONSES	177	(69)
*NON-RESP.	79	(31)
'GONE-AWAY'	51	(17)

* Includes 1 refusal

NB. It should be noted that the percentage figure for "gone-away" is low as 53 known "gone-away" entries were removed prior to the posting. However, a guestimate of the figure can be made. In the pilot survey, a "gone-away" figure of 20% was experienced for both "manufacturing" and "all" sectors. In the main survey the "gone away" figure for manufacturing rose to 25%, giving a 24% figure for the whole of the manufacturing listing. Therefore, it would be fair to suggest a "gone-away" figure of between 20 to 24% for the postal survey as a whole.

In conclusion, the return statistics show that 256 establishments were surveyed with 177 responses received, representing a high response rate of 69%. This level of response compares very favourably with that achieved by Scott and his co-workers in their investigations of agglomeration. For example, Scott (1988b) achieved a response rate of 10.2% or 60 establishments when studying the semiconductor industry of Silicon Valley. In his studies of the printed circuit boards industry of Southern California with Kwok (Scott and Kwok,1989), a response rate of 17.6% (36) was gained, whilst a study of the region's aircraft and parts industry eventually gained 46 useable responses after an intitial mail-shot to 986 establishments (Scott and Mattingly,1989).

For this study, response rates by sector were headed by Computer Services, producing a rate of 76%, with two other sectors, Electronic Data Processing (73%) and Telegraph and Telephone Apparatus (75%), gaining rates above the sample average of 69%. Only two sectors, Aerospace (57% but if include refusal = 65%) and Electrical Instruments (44%) failed to gain a response rate greater than 60%. In both these cases, small sample numbers imply that the addition of only a couple of further responses would have taken them above the 60% level.

Gone-Aways

The "gone-away" figure for the complete survey was quite high, the percentage rate being in the low 20s, but as was suggested earlier, this set of establishments proved

interesting in itself. For the set did not only comprise those establishments whose post was returned as "gone away", with subsequent efforts to trace them proving fruitless.

A series of other instances also transpired within the "gone-away" grouping revealing, amongst other aspects, a variety of economic processes occurring within the local economy. For example, one of the most obvious processes was that of the firm being in the hands of the liquidators, a reminder, if needed, of deaths as well as births of firms in even the most bouyant of sectors. Other closures had occurred in multi-site companies where the company had made a selective decision to close the site, sometimes, but not always, transferring the jobs elsewhere. This would seem to indicate the continued loss of jobs through restructuring processes highlighted by the work of Massey and Meegan (1982). In other cases the establishment was discovered to be a "dormant company", nothing more than a registered name in a file in a solicitor's office or a postal address for a company located outside the region. Such cases are examples of where quantitative statistics alone can lead to spurious conclusions.

In a further case the establishment had been part of a company whose major activity was in high technology industry. However, it had recently been the subject of a management buy-out/divestment and the product of the particular site would not now lead to its classification as high technology industry. This anomaly arose from the

research tools used and others also occurred. Hence, the listing had asked for all high technology establishments located in Hertfordshire. In an interesting anomaly it transpired that the locational reference had been that of postal address but that postcodes do not necessarily identically match local government administrative boundaries. Hence, several returns were excluded because although these establishments had a Hertfordshire postcode they were, in fact, located in Cambridgeshire, to the east of Royston (itself located just within Hertfordshire) to be precise.

The "arbitrary" drawing of the research's spatial boundary as the local government administrative area of Hertfordshire and its implications is discussed in greater detail in Chapter Seven, but the issue of postal address also has a particularly interesting twist. Recent work has highlighted that postal address may well be a locational factor in itself, especially for high technology firms (Massey, Quintas and Wield,forthcoming; Saxenian,1989). Many high technology firms located in Cambridge have suggested the status aspect to having a Cambridge address. Indeed, firms located within the postal boundary of Royston, and hence given a Hertfordshire address, have been sufficiently "miffed" to have recently attempted to have the address changed to that of a Cambridgeshire code.

A similar situation arose from one of the questionnaire responses concerning telephone number. The company wished to move right out of central London but wanted to retain a London telephone code. Premises were found for them and to

their surprise the site was within Hertfordshire, the company initially believing the premises were in Middlesex and that 01 numbers were not available in Hertfordshire![57]

5.6 Summary

Thus this chapter has outlined a plan of exploration of a possible British New Industrial Space. The design of this exploration, as a project of two stages, may be seen as a direct result of the critique of empirical studies of New Industrial Spaces put forward in Chapter Four.

In highlighting the initial steps of identification of a high technology New Industrial Space, the chapter revealed that the neglected county of Hertfordshire, part of the Western Crescent agglomeration, represents a prime candidate for the title British New Industrial Space. Thus the exploration began to investigate this candidature, with stage one, a scan of Hertfordshire, being successfully undertaken. The first aim of the scan was to furnish further and updated evidence of a production agglomeration of high technology industry in Hertfordshire (in all its characteristics). It is the results of this scan, gained from both the postal survey and the gathering of other secondary data, which are discussed in the following chapter as the hypothesis "High Technology Hertfordshire: A New Industrial Space" is interrogated.

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[57] How they view the fact that their STD code will now be 081 is uncertain!

CHAPTER SIX: High Technology Hertfordshire: Apparently a New Industrial Space

6.1 Introduction

> "Hertfordshire lies, geographically and probably in its own estimation, head and shoulders above London - a favoured county in terms of its situation on the map, its relative prosperity and its "green mantle" of countryside." (Financial Times 2.4.86) [see Figure 6.1]

Hertfordshire, a county of 630 square miles, has just seen its population break the one million mark. Whilst the county town of Hertford only has a population of approximately 25,000 the most densely populated part of the county is the south-west area centred upon Watford (see Figure 6.2). This area's population stands at over 150,000, whilst other major areas of population in the county are Hemel Hempstead and, moving east, St.Albans and Stevenage, all of which house approximately 80,000 people. Of the county's population, almost half are economically active and the county's employment total stood at almost 393,000 in 1987. In contrast, Hertfordshire's unemployment rate of June 1989 stood at 2.5% in comparison to the South East region's rate of 4.4% and Great Britain's figure of 6.8% (Planis,1989).[58]

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[58] These rates are calculated using a Hertfordshire County Council definition of unemployment. The "official" DOE figure for the county in June 1989 put the figure at 2.2%.

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The county's "favoured" situation includes its comprehensive communications network. North-South trunk routes passing through the county include the M1, A1(M) and M11 and, running West-East, the M25 provides easy access to the national motorway network. Alternatively, the county is traversed by four mainline rail routes, all electrified, and new stations have recently been opened. Air travel is catered for by either Stansted Airport or Luton International Airport, with Heathrow Airport less than an hour's journey away.

A second advantage is the county's historical connection to London, with a variety of "country seats" bearing witness to Hertfordshire's location as only a day's ride from London during the seventeenth and eighteenth centuries. In present times, research has continued to identify the advantage of "proximity to London" not merely through the modern equivalent of country seats based upon commuting on the electrified rail network (see Hamnett,1990) but, also, due to London's continued role as a market and centre of government[59] (Wray et al.1974; HCC,1984; also Chapter Seven).

Yet the growth of Hertfordshire as a major population centre and, as will be seen, site of production is a phenomenon of this century. Between 1911 and 1951 Hertfordshire's population doubled in size to about 610,000. Indeed, between 1931-51 the county experienced the

[59] It will be seen that the combination of these factors, government as market has been of particular importance to Hertfordshire's prosperity.

fastest population growth rate in England, a mere quarter of which was due to natural increase (Wray et al.,1974,p.15).[60] Such impressive growth did not wane in the post-war (WWII) era either. Between 1951 and 1971, Hertfordshire posted a further 65% growth in its population whilst its employment similarly grew by 67% (H.C.C.,1984). However, over sixty years of almost continuous growth in the county gave way to a period of uncertainty and instability during the 1970s and early 1980s, as the national economy went into a period of restructuring characterised by the deepest recession for fifty years.

6.2 An Industrial History of Hertfordshire

The "light industries" of the 20s and 30s

Coming into the twentieth century, the traditional industries of Hertfordshire were agriculture, malting and brewing and the now defunct domestic industry of straw plaiting. In addition, two further industries (which still are) of importance to the county were the industries of paper making and printing. However, as Wray et al. (1974) commented:

> "This is a county that, because of its lack of mineral wealth (other than gravel) and its geographical position, was completely untouched by the first industrial revolution".

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[60] The early part of the following summary of Hertfordshire's economic history is predominantly drawn from the work of Wray et al. (1974), the culmination of a four year research project upon post-war planning and industry in Hertfordshire. Much of the section covering the 70s and early 80s is taken from Hertfordshire County Council's (1984) review of its structure plan, "Ten Years After".

(op.cit.,p.15)[61]

Such a situation rapidly changed during the 1920s and 1930s, however, as the geographical focus of national industrialisation moved to Greater London and the West Midlands through the growth of a series of new industries such as electric power, chemicals, synthetic materials and engineering based on the internal combustion engine (Hall,1981). In particular, Hertfordshire became the location for a wide range of representatives of the new industries, often relocating from London (a process accentuated during the war years for strategic reasons). Examples of such firms were Addis Ltd (brush and plastics manufacture;1920) and the British American Optical Co. Ltd (1931).

Moreover, whilst firms were attracted by the availability of labour consequent on the county's population growth, inward investors were also encouraged by the establishment of the two garden cities of Letchworth and Welwyn. Firms locating in the "cities" included J.M.Kent and Sons (bookbinding); British Tabulating Machine Co. Ltd (now ICL); Imperial Chemical Industries (ICI) in 1933; The Westinghouse Morse Chain Co. Ltd and Royal Exchange Insurance. The garden cities also attracted foreign direct investment through American-owned firms that set up with increasing frequency in the South East during the inter-war years. Such examples were Spirella Company of Great Britain

[61] As Allan Cochrane pointed out, whilst the county did not represent a **site of production** for the first industrial revolution it was, however, an important **site of class formation** during this period (eg. Hobsbawn,1969,pp.80-83).

Ltd (1910) and Norton Abrasives who located in 1931 (Wray et al.,1974; postal questionnaire returns). One other company also migrated to Hertfordshire during this period and represents the first beginnings of what is now one of the bedrock industries of Hertfordshire. In 1934 the De Havilland Aircraft Company (now Hawker Siddeley) located in Hatfield. By 1986, the aerospace industry **directly** employed over 20,000 workers in Hertfordshire, representing 13% of the industry's total UK workforce (Lovering,1987, Table 9, see later this chapter also).

Yet it should be noted that the growth of industry in Hertfordshire during this period was not purely due to inward investment. Firms which introduced new industries to the county were also being set-up locally. For example, W.L. Thurgood (Coachbuilders) Ltd. (1925), Jack Olding (Industrial) Ltd. (construction equipment;1935), Geo.W. King (cranes, hoists and automatic machinery;1937) and Murphy Radio Ltd which set up in Welwyn Garden City.

Hence, by 1948, the nineteenth century industries of agriculture, brewing and malting had been superceded in importance by newer industry. **Paper and printing** still retained its position as a major employer with over 15,000 employees or 6.8 per cent of all employment in Hertfordshire. However, **engineering** now accounted for 8 per cent of all employment closely followed by **vehicles and aircraft** with 7 per cent (Wray et al.,1974,Table 2.1).

The Post-World War II Boom

The beginning of this period marked not only continued growth of existing industry in the county but, also, a continuation of the role of Hertfordshire as destination point for the exodus of people and industry from London. The fundamental difference, however, was that the accomodation of such "overspill" occurred within a new **planned** framework.

The series of post-war Royal Commissions, Committees and Acts of Parliament, which investigated strategic issues such as the geography of the industrial population and created a modern planning system to deal with such issues, set the framework for the planned development of Hertfordshire (see Cullingworth,1982). Indeed, Hertfordshire's planned growth during this period epitomised an era of interventionist policy, both at the regional and county level.[62]

To meet the strategic role set for Hertfordshire, of continued accommodation of a planned overspill of population and industry from London, four new towns were designated for Hertfordshire between 1946 and 1948 - Welwyn Garden City, Hatfield, Hemel Hempstead and Stevenage. At the same time, any manufacturing growth (requiring factory

[62] Hertfordshire also acts as an example of the failure of much of this policy. For example, Wray et al. (1974) conclude that, even during this period of "tight" planning control, the county contributed as much to the alleviation of London's overspill problem through unplanned growth as it did through its planned New Towns (op.cit.,p.110).

space above 10,000ft^2) within Hertfordshire or the South East more generally required an Industrial Development Certificate (IDC). Overall, during this period, policy was against the provision of such certificates except in designated new or expanded towns and any additional growth would be re-directed to the Development Areas through this "push" factor and the additional "pull" factor of capital grants available to companies in such regions. However, IDCs did not cover smaller industrial developments and it soon became clear that continued new building in the county for firms outside the area, especially from London, was putting undue stress on the county's infrastructure. Thus, from 1955, new building for manufacturing industry was restricted to occupation by local firms in South West Hertfordshire and, by 1963, this restriction had been extended to cover the whole county (Wray et al.,1974).

A similar story followed for office development. Whilst decentralisation of London offices was encouraged during the 1960s, particularly through the government Location of Offices Bureau, in 1965 relocation into Hertfordshire and any new building of offices over 3,000ft^2 in the county was restricted by the need to gain an Office Development Permit (ODP). Just as with IDCs, however, such permits failed to curb smaller office developments and thus, by the early 1970s, a new county office policy was proposed to curb development only to those "offices serving the local community" (Wray et al.,1974,p.63).

So, by the early 1970s, and the Second Review of the County Development Plan, Hertfordshire had become an area of

restraint of industrial and office development. Indeed, by this time, three of the four major areas of planned growth (ie. the New Towns) were already "full" and had seen their Development Corporations wound up. Thus, the plan review of 1972 proposed to continue the overall planning policy of restraint in the face of the major **problem** of continued industrial expansion, not through new arrivals but rather, through the growth of existing firms. An attempt to relieve this development pressure led to a policy statement that:

> "The County Council...will encourage Hertfordshire firms seeking re-location to settle in the new growth areas proposed in the 'Strategic Plan for the South East'...This recommendation would accord with the County Council's aims for Hertfordshire to become an exporting authority on a par with Greater London." (quoted in Wray et al.,1974,p.71)

In summary, the post-war period saw a massive expansion of both population and industry within Hertfordshire, a continuation of the pre-war trend. However, although this expansion had been initially planned as the accommodation of London's overspill, its rate was such that by the 1960s strong attempts were being made to restrict the growth of both population and industry. Indeed, in the face of only limited success in such restraint policies due to continued endogenous growth, by the 1970s Hertfordshire was viewing itself as a provider of "overspill" itself rather than accommodater. This turn-around from receiver to provider can be viewed as the outcome of Hertfordshire's astonishing ability during the post-war period to attract the new

growth industries, an ability not least due to the designation of four of the country's earliest new towns within the county.

Between 1948-71, Hertfordshire experienced a 59% increase of employment in its secondary sector representing an increase of over 70,000 jobs to 166,000 jobs. With tertiary sector employment increasing by 14.6% to over 174,000, the county posted an overall job growth of 28.9% (Wray et al.,1974,Table 5.6). Indeed, taking a sub-period of 1961-71, whereas overall employment in Britain decreased by 1.2%, the county experienced a growth rate of 17.7% with the county's new towns witnessing a growth rate of 28.1%.

A more detailed breakdown of the industrial structure of the county in 1971 by Wray et al. (1974) revealed quite starkly the problem faced by local planners in the late 60s and early 70s in their attempts to restrict industrial growth. For, by 1971, every major national (manufacturing) growth industry between 1948-71 was represented in Hertfordshire bar one, coal and petroleum products, and Hertfordshire had a higher proportion of employment in all these industries than the country as a whole (op.cit.,p.115). **Vehicles** had grown to become the largest manufacturing sector in the county employing over 26,000 or 7.5% of total employment, almost wholly in the **aircraft and aerospace** industries (op.cit.,Table 7.1). Following closely, and partially linked to the aerospace industry, was **electrical engineering** accounting for 7% of total employment. Ranking third was the traditional industry of **paper, printing and publishing** employing nearly 22,000

workers followed by **mechanical engineering** employing over 20,000 or 5.9% of total employment. Other important manufacturing sectors included **other manufacturing industries** with 4.6% of total employment; the rapidly growing **chemicals and allied industries**, particularly **pharmaceuticals**, employing about 14,000 or 4% of all employees in the county; **metal goods not elsewhere specified** with 11,000 employees and **instrument engineering** employing 9,000 or 2.6% of all Hertfordshire's employed population.

Such growth of manufacturing employment, impressive though it may have been, was, however, outstripped by that which occurred in the tertiary sector during this period. Of all the tertiary sectors whose employment grew nationally, Hertfordshire experienced even greater growth. So, for example, **insurance, banking, finance, business services** grew by 167.9% within the county to over 10,000 and **professional and scientific services** grew by 66.4% such that it employed over 50,000 people, 15.29% of Hertfordshire's total employment.

Today, a large part of the above list of major industrial sectors in Hertfordshire would be included in one list or another of high technology industry. Moreover, this historical picture of the county, as an area of rapid industrial growth (critically important as a site of accumulation for the nation as a whole) must be viewed as a legacy. A legacy which, despite the uncertain times of the 1970s and 1980s ahead, laid the basis for a renewed period of high technology industrial growth.

1974 and on: recession and restructuring

Following Hertfordshire's rapid post-war growth and, subsequently, the need to restrict such growth, moving into the 1970s the assumption was maintained that the future would involve the continued restriction of development pressure. Such a policy of restriction similarly agreed with wider regional objectives which now assigned the county a restraint role. Hence, Hertfordshire's future economy was viewed primarily on the basis of continued support of local firms and the discouragement of any in-migration, with a general period of "stabilisation" for the county envisaged (H.C.C.,1984,p.4-7).

However, such restrictive policy was to be first brought into question when the recessionary period of 1974-6/7 challenged the fundamental assumptions (from the post-war era) of continued national and local economic growth. In line with national trends, Hertfordshire's unemployment rate rose sharply from 0.8% in 1974 to 3.1% in 1977, although these figures still stood significantly below the equivalent regional and national figures for 1977 of 4.4% and 6.0% respectively (H.C.C.,1984,Figure 1). Paradoxically, despite the increased numbers of unemployed, reports still abounded of chronic labour shortage and any skilled workers made redundant were quickly re-employed. In fact, during this period there was a marked recruitment of labour by local high technology firms such as Marconi, EMI Medical Instruments and BAC (op.cit.,p.10). Such reports confirmed a policy response which viewed the rise in unemployment as a short-term phenomenon, with any

relaxation of restrictive policy likely to damage the longer term balance between population and employment. Thus, when the county structure plan was submitted in 1976, the key assumption of a vigorous local economy was still in place and Hertfordshire was viewed both at county and regional level as an area of continued restraint or "low growth" (op.cit.,p.15).

But the expected recovery from recession nationally was weak and short-lived, with the onset of a further major recession between 1979/1980-82. Yet, whilst the national economy struggled to recover from the first recession, Hertfordshire's economy quickly did so, reinforcing the belief of a vigorous economy. Unemployment fell, vacancies rose and skill shortages continued to be reported. Indeed, a county council report in 1978 expressed the continued pressure for development and employment growth from the electronics and computer sectors in the county. Furthermore, such development pressure was not only occurring through the expansion of major firms within the area such as Marconi Avionics[63] but, also, as recognised in the County Annual Monitoring Position Statement No.5 (1979):

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[63] Interestingly, the wide-ranging role the Ministry of Defence plays within industrial policy is highlighted by the application for both floorspace and subsequent employment expansion by local firm Marconi Avionics. Such expansion was required due to the firm winning contracts from the MOD concerning the Nimrod and Tornado aircraft. However, this growth conflicted with county industrial policy but the council's opposition was withdrawn when the firm's application was supported by the Ministry of Defence on the grounds of national interest.

"...smaller electronics/computer firms are already showing very high growth rates and the environmental and accessibility attractiveness of the county could easily 'over heat' those areas in Hertfordshire where the electronics industry is concentrated." (quoted in HCC,1984,p.20)

Abolition of ODPs and national industrial policy which identified and encouraged the (especially "high technology orientated") small firm sector, merely added to the concerns of the county that its policy of restraint could be undermined. Indeed, even as a further recession began to take hold with the closure of some large manufacturing firms during 1979/80 (eg. Kodak, KL Foundries and Borg Warner), potential distress was seen as short-term with the abandoned premises offering possibilities of conversion to meet great demand for small premises in the county (HCC,1984,p.22).

However, even Hertfordshire was unable to ride-out the acceleration of structural change which occurred as the recession intensified in the early 1980s. Between April 1980 and March 1981, unemployment in the county rose by over 120% to reach 5.5% and, by 1982, had reached 7.5% (H.C.C.,1984,p.29). Although this rate still compared favourably to the national figure of 10.1%, the eventual response to sustained job loss involved the **relaxation** of aspects of the county's industrial development restraint policies and in a significant, and symbolic, move the county published a promotional leaflet entitled "Hertfordshire - County of Opportunity" in 1983.

As with the situation nationally, a particular feature of the rise of unemployment was its basis in substantial manufacturing job loss and the closure of a number of large firms in the county such as Bowaters, Rank Radio and John Dickinson. However, what was particularly to identify Hertfordshire in comparison to other counties was that whilst the structural change which was taking place was, on the one hand, producing large scale job-loss in a wide range of older, traditional manufacturing industries, on the other hand, the county was experiencing the growth of newer "technologically-based" industries. Whilst a rapid increase in unemployment was occurring, planning applications continued to suggest significant levels of new floorspace and employment with continued demand for small premises and the redevelopment of sites vacated by the closure of large firms (H.C.C.,1984,p.28-31).

The county's reaction to this structural change did not merely involve the relaxation of the policy of restraint. For example, in 1983, the county also approved its first specific policy towards "high technology" industrial development. In the same year, the Annual Monitoring Report (H.C.C.,1983) also concluded that prospects for economic growth in the county looked promising with a significant increase in "high technology" developments within the county and, by 1984, the ubiquitous notion of a "science park" development had been raised (H.C.C.,1984,p.33-35). Indeed, the shift in policy emphasis and the entry into the vocabulary of such terminology as "high technology" and "science parks", marked the recognition of significant high technology industrial development within the county, what

has been described as the "third wave" of economic development within the region (Rainnie et al.,1988). At the time of Rainnie et al's report, the county council were claiming that half of all industrial development in the region was in industry defined as "high technology" and, for example, in 1987 around 90% of all manufacturing proposals approved in Welwyn/Hatfield and Stevenage were in "high technology" (quoted in Rainnie et al.,1988,p.4).

This post-recession re-orientation of the county as **the** location for high technology industry was confirmed by a series of survey articles in the national press which used titles such as **"Hertfordshire: Holding on to its place in the sun"** (Financial Times 2.4.86) and **"Hertfordshire: The high tech renaissance"** (Financial Times 27.5.88) [see also Estate Times, 1.7.88; Chartered Surveyor Weekly, 3.11.88]. Furthermore, the perceived growth of a high technology ensemble within the county was confirmed by a series of reports which declared Hertfordshire as the "high technology county of Britain" (Begg and Cameron,1987; 1988; Hall et al.,1987).

For example, a ranking of counties by relative concentration of high technology employment, in which GB = 100, ranked Hertfordshire first with a score of 244 (Begg and Cameron,1987). The much vaunted Berkshire was placed second scoring 195. Moreover, the authors' further disaggregation of the figures by urban area produced confirmation of Hertfordshire's position. In a ranking of Great Britain's 161 urban areas the lowest placed of Hertfordshire's seven representatives was Hertford in 41st

position. In other words, all Hertfordshire's urban areas were placed in the top 25% of high technology urban areas in Britain. In addition, the list was headed by Stevenage with Welwyn/Hatfield placed third. Interestingly, Begg and Cameron (1988) dissected these overall employment rankings by employment in "high technology manufacturing" as against "high technology services". Both the above towns held their positions principally due to the presence of massive high technology manufacturing employment (ie. British Aerospace). However, four of Hertfordshire's seven urban areas also had above average concentrations of high technology services.

In essence, during the late 1970s and particularly through the 1980s, as the county came to recognise the growth of a high technology ensemble within its boundaries so, at the national level, the importance of the county (the "space") to the geography of high technology in Britain was similarly being acknowledged. **However, although such recognition did not occur until the 1980s, it is crucial to realise that it was the culmination of a much longer trend of development of high technology industry in the county.** Indeed, the seeds of this development were planted at least as early as 1934 with the attraction of De Havilland to Hatfield. As Rainnie et al. (1988) explained:

> "The dynamics of the local [Hertfordshire] economy can largely be explained by the linked development of two sectors - one a long term phenomenon, the other more recent. The first being defence and defence related firms (particularly those concerned

with aircraft production), and the second high technology industries[64]." (Rainnie et al.,1988,p.2)

Hertfordshire and the defence industries

In 1983, a list of Hertfordshire's top ten employers revealed that the majority were within the defence industries, predominantly aerospace and increasingly of importance within the industry, electronics.[65] The list included the UK's largest defence equipment producer, British Aerospace, as well as other major defence companies such as GEC/Marconi, Rolls Royce and Lucas Aerospace (Rainnie et al.1988,Table 1). Moreover, measured by the number of defence industry sites within a county/regional council in 1985, Hertfordshire was placed fourth with over 10% of national sites (P.Southwood,1985; quoted in Speller and Kraithman,1987) leading to an estimate of the number of direct jobs the defence industries provide in Hertfordshire as being 25,000 or over 6% of the county's total employment (Rainnie et al.1988).

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[64] This represents a possibly confusing use of the term "high technology industries" for aerospace and defence firms are, in fact, industries usually defined as "high technology". However, the distinction serves a useful purpose in differentiating between two periods of high technology development within the county. That is, between "old" high technology industries such as aerospace and those "newly emergent" high technology industries such as computer services.

[65] At the close of World War II avionics were virtually non-existent within combat aircraft. They now account for up to 40% of combat aircraft costs (Simpson,1988). Indeed, Hayward (1987) has suggested that the cost share of electronics in combat aircraft is likely to increase to over 50%.

The aerospace industry

Hertfordshire is one of the top counties in Britain in terms of numbers employed in the defence industries, with over half of these jobs being within the aerospace industry. Yet, as was noted earlier, Hertfordshire's aerospace industry was effectively born in 1934 with the relocation of De Havilland from Edgeware to Hatfield. Even in the five years prior to the second world war the industry experienced rapid growth with De Havilland increasing its Hatfield workforce from an initial 900 to 4,280 (Rainnie et al.,1988). By 1943, aircraft production was Britain's largest industrial operation and in 1949 the sector was the county's second biggest manufacturing employer (cf. p.265).

Further developments in the industry post-war enhanced the county's position. In 1953, English Electric Aviation (later to become BAC) relocated to Stevenage from Luton. In the 60s the De Havilland company was incorporated into Hawker Siddeley Aviation and these sites, as well as those of BAC, joined by sites set up with the arrival of Handley Page into the county. Hence, by 1971, there were 16 factories in the county with the aerospace industry accounting for 7.5% of total employment (cf. p.269). In 1977, Hawker Siddeley Aviation was nationalised along with Hawker Siddeley Dynamics, BAC and Scottish Aviation to form British Aerospace (BAe), the biggest individual aerospace manufacturer in Western Europe and now (after privatisation) one of Britain's largest private industrial employers. Today, BAe is the largest employer in

Hertfordshire but the solidity of this employment has become a matter of deep concern.

British Aerospace (BAe)

A recent study of BAe identifies three broad phases of restructuring of the company since its creation in 1977 (Bristol City Council et al.,1988). The first phase stemmed from BAe's formation and essentially involved "putting the label BAe on" the variety of parts which made up the company. Considerable duplication of facilities and staff arose with the company's creation from the amalgamation of four firms but, in the context of sharp increases in MoD procurement, BAe continued to make significant profits through its major activity of defence equipment production.

The second phase in the company's development was linked to the appointment in 1980 of a new Chairman, Sir Austin Pearce, whose role was to prepare the company for privatisation. However, this period also marked the first signs of a change in the company's market orientation which may be viewed as a product of changes in the nature (and size) of British procurement policy, changes principally aimed at achieving commercialisation and internationalisation of the defence industries (Simpson,1988).

Firstly, during a seven year period beginning in 1978-79 and ending in 1985, a substantial rise in defence procurement expenditure occurred. This increased expenditure particularly favoured the aerospace and

electronics industries which account for half of all defence procurement (Simpson,1988,Table 1). Indeed, it is estimated that the MoD alone accounts for about 45% of the output of the aerospace industry (Lovering,1987). But, since 1985, defence expenditure has been declining in real terms. Secondly, government policy has increasingly aimed at internationalisation of the defence industries through, on the one hand, state sponsored international collaboration in the design, development and production of weapons systems and, on the other, export market penetration. Thirdly, greater competition and cost effectiveness has been introduced into defence procurement through the increased use of competitive tendering and the gradual switch from cost-contracts to fixed-price contracts. Simpson (1988) describes this as an ongoing attempt to "commercialise" relationships between defence firms and the MoD.

Thus, for BAe, this period marked the first threatening signs concerning its major traditional market, UK defence procurement, with increased competition and greater cost-effectiveness required in a shrinking market. At the same time, the company also responded to other changes in procurement policy. Thus it became involved in a series of collaborative international projects and commenced a re-orientation of its role to that of an aggressive, world-oriented company, rather than an "agency" of the Ministry of Defence (B.C.C, et al.,1988).

The third phase can be viewed somewhat as the continuation of the company's re-orientation, but involving a shift of

gear as the company has entered "the commercial and market era". In fact, the company has reshaped radically to the point of changing, to some extent, just what it "is". Since Professor Roland Smith's arrival as Chairman in 1987 the company has bought the Royal Ordnance Factories, a German military optics company, a Dutch construction company, Sperry, a share in the software house Systems Designers (subsequently merged with Scicon) and a US simulator company Reflectone. In 1988, BAe also acquired the Rover car company. BAe now has a series of collaborative projects with virtually every other major aerospace company in the world as well as many other firms, particularly within the electronics industries. Indeed, rumours have abounded of BAe's desire to link up with a major electronics company and discussions have been held with a variety including GEC, Thorn EMI and the French company, Thomson.

As the company enters the 1990s it is concentrating on, and investing in, a chosen set of core activities represented by the separate divisions or "autonomous management companies"; Rover, Civil Aircraft, Military Aircraft and Guided Weapons and Electronics. The company's major priority has been, and still is, to maintain its position in military markets. Indeed, prior to the acquisition of Rover, over 70% of BAe's sales and almost all the company's profits were accounted for by military production (Harbor, 1987). Reduced UK defence spending and internationalisation of the defence industry has implied that an increasing share of these sales and profits are now accounted for by overseas sales. Between 1981-87, the company's exports as a percentage of sales increased from 61.8 to 68.7%. Over the

same period, export sales of guided weapons and electronics, as a percentage of divisional sales, increased from 32% to 48% (B.C.C. et al.,1988,Table 5). This is significant when placed within the context that, in 1987, the guided weapons and electronics division alone accounted for 92% of the company's profits (op.cit.,Table 7). However, although pre-tax profits have fluctuated between £120m and £180m between 1984-87, after taxation and exceptional items the company actually made a loss in 1987.[66]

Over the 1980s, employment in "traditional" BAe plants fell by over 7,000. Between 1980 and 1986, numbers employed dropped from 79,300 to 74,900 despite the inclusion of 3,000 employees with the acquisition of Sperry's in 1981 (B.C.C. et al.,1988,Table 4). However, by the following year, employment had jumped to 93,000 employees through a series of company acquisitions. Within the context of increasing competition in tightening markets, especially and most crucially within military markets, the primary aim for each operating division has been announced as increased efficiency with a drive to cut costs by a third by 1992. A variety of methods to achieve this aim are to be used including shedding labour. It is within the context of this continued restructuring and rationalisation by the company that worries about its employment base in Hertfordshire have been expressed and recently realised.

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[66] In 1990, BAe increased profits before tax and exceptional items by 37% to £400million on turnover up 16% to £10.5 billion. Pre-tax profits rose 13% to £376 million due to exceptional profits in 1989 (Times 27.2.91).

BAe in Hertfordshire

At the beginning of 1988, BAe employed over 14,500 employees in Hertfordshire concentrated in four major production sites and representing three divisional headquarters. The major sites were split evenly between Stevenage and Hatfield.

The Six Hills site at Stevenage was, and still is, the Divisional Headquarters for the Dynamics Division, responsible for land launched anti-aircraft and anti-armour defensive weapons systems such as the highly successful Rapier defence systems. The other Stevenage site is Divisional Headquarters for the Space and Communications Division and as such is the largest organisation of its kind in Europe. Projects include a variety of satellites such as the Inmarsat-2 series of maritime communication satellites, Skynet 4 military communications satellites and European Communication Satellites (ECS) for the European Space Agency. The division is also working in conjunction with Rolls Royce on "Hotol", a new type of space vehicle, essentially an unmanned aeroplane in space.

Hatfield encompasses the original site of the de Havilland Group and is the Divisional Headquarters of the Civil Aircraft Division. It is the centre of BAe's current major civil aircraft venture, the Type 146 regional jet airliner. The fourth site in 1988 was the other Dynamics Division site in the county at Manor Road, Hatfield. Amongst other projects it was the centre for air-launched missiles and the design and development of a new generation of

propellers for the Advanced Turboprop airliner.

But, in March 1988, British Aerospace announced plans to streamline the company with an expected loss of 5,000 jobs (none compulsory) over the following 12-18 months. The Dynamics Division, in particular, was targetted to lose 3,500 jobs, mostly through the rationalisation of manufacturing activities (B.C.C. et al.,1988,p.3). In a restructuring which has had a variety of both positive and negative consequences for the Hertfordshire sites, there has been a marked northwards shift of manufacturing whilst the South has seen its position as region of research, design and development and advanced engineering reinforced (op.cit.,p.14). Although not an explicit aspect of the company's strategy, this geographical division of labour mirrors and reinforces that depicted for high technology industry as a whole in Chapter Three.

Whilst the Dynamics Division site at Stevenage has seen a consolidation of its guided weapons work, with its employment standing at 7,000 at the end of 1989 (questionnaire response), a major blow has been the closure of the Manor Road site in Hatfield which had previously employed approximately 2,500 workers. It is estimated that 1,200 of these jobs will be transferred to the Dynamics Division at Stevenage leaving a net job loss of approximately 1,100 (Rainnie et al.,1989). In addition, a planned reduction in employment at the other Hatfield (Civil Aircraft) site, from 4,500 to 3,400, will take place up to 1994. However, Hertfordshire has not been hit by the latest series of (compulsory) redundancies announced by the

company at the end of 1990. Approximately 5,000 jobs at Preston and Kingston will be lost within its Military Aircraft division and 500 more will be lost within its Rover subsidiary at Longbridge, Birmingham (Beavis et al.,1990).[67]

Thus, although the aerospace industry may increasingly be moving towards a "leaner" profile, it is, and has been, the bedrock of Hertfordshire's high technology industry, the industry's growth stemming from as far back as the inter-war years. In fact, the eight postal questionnaire returns for the sector reveal this long history with the average date of commencement of trading in the county being 1959 for aerospace, compared to an average of 1976 for all high technology sectors. Today, six of these establishments, including two of BAe's remaining three major production sites in the county and Lucas Aerospace, employ over 10,000 workers. All the establishments bar one carried out some form of HQ function with 50% of the sites carrying out all the possible "production functions" listed. R&D and manufacturing are carried out in 63% of the respondents with design and marketing carried out in 75% of the establishments. In essence, the postal survey merely served to confirm the (historical) importance of the aerospace agglomeration in Hertfordshire, not only through sheer numbers employed but also, qualitatively, in terms of the actual type of jobs available, with the full range of "production" functions being represented in the county.

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[67] On 21st March 1991, BAe announced a further 4,700 redundancies in its commercial aircraft and missile divisions (Guardian 22.3.91). Hatfield is to lose a further 1,470 jobs leaving 3,400 and the Dynamics site at Stevenage is to lose 500 jobs.

The (defence) electronics industry

Yet the historically close, and increasing, links between the aerospace industry and parts of the electronics industry must not be forgotten. For example, approximately one-third of the value of military aerospace equipment today is in electronics and, in the situation whereby the domestic electronics industry as a whole posted a £1b trade deficit in 1984, the most defence-oriented electronics sector, radar and electronic capital goods, still achieved a trade surplus (Lovering,1987). In fact, it is the combination of the aerospace and certain electronics sectors which constitutes the "defence industries" and just as with, and partly due to, the aerospace industry, the history of the electronics industry in Hertfordshire is an extended history. This is no better illustrated than by Hawker Siddeley Dynamics, a spin-off from the original (aerospace) De Havilland site at Hatfield, the firm being set up in 1940 and now employing 220 people (questionnaire response).

In fact, by 1949, the engineering sector as a whole (inclusive of electronics) was the largest manufacturing sector in the county (cf. p.265) and the co-existence of the electronics and aerospace industries meant that:

> "The county was going to enter the post war period with an already well developed share of "high technology". In 1951 the county had a high tech location quotient of 2.2, the second highest in the country after Middlesex (Hall,op cit.,p.91)."
> (Rainnie et al.,1988,p.9)

By 1971, after a period of continual growth in the county's employment, the aircraft and aerospace industry and electrical engineering were still the two largest manufacturing sectors in the county, accounting for over 14% of total employment. This growth continued during the following decade so that by 1981, Hertfordshire had 45,000 high technology jobs (Hall et al.,1987). This number included the consolidation of the pharmaceuticals industry within the county, which now employs about 5,000 people in 17 firms (Rainnie at al.1988), but the majority of employment was to be found within the county's aerospace and electronics industries. It is at this point in time that Hertfordshire was identified as the "high technology county of Britain" (see Table 3.2,p.74; Begg and Cameron,1987).

The basis of this position was the "defence industries". Whilst the county's location quotient for aerospace employment in 1981 was a still highly significant figure of 5.5-6 (see Table 3.4,p.95), the county had seen continued growth of its high technology employment through the expansion of defence electronics in particular. During the period 1975-81 only one of Hall et al's (1987) chosen high technology manufacturing sectors, the heavily defence-oriented radio, radar and electronic capital goods sector, experienced job growth nationally. Nearly 50% of this national growth, accounting for almost 5,000 jobs, occurred in Hertfordshire alone (op.cit.,Fig.3.10). Today, examples of major defence electronics companies, apart from the "aerospace" companies such as BAe and Lucas Aerospace, include various GEC Avionics' divisions located at

Borehamwood but also, for example, the Sonar Systems division at Welwyn Garden City, located in 1978 and at present employing 130 people. Another GEC company, and one of the county's major employers, is GEC-Marconi with separate plants at Borehamwood and St.Albans. Further major defence electronics companies are Fernau Avionics which located in the county in 1972 and employs 70 workers, Racal Acoustics employing 220 people and a branch of the major US company Tektronix Inc., set up in 1968 and now employing 230 workers (questionnaire returns).

Yet Hall et al's (1987) work also showed that although the basis of Hertfordshire's position as a leading high technology county was the defence industries, its position was not solely reducible to these industries. For their work, as well as confirming the presence of the pharmaceuticals sector within the county, also identified the presence of the electronics industry in its entirety. In other words, not merely defence electronics but also civil electronics and, especially, the presence of the new computer industries. In fact, the problems of defining and distinguishing between electronics, "defence electronics" and other "defence industries" such as aerospace is acute. Lovering (1987) pragmatically takes employment figures for the electronics, aerospace and R&D sectors when reviewing defence electronics employment in the South East. In this instance, having reviewed the aerospace sector in particular and pinpointed examples of major defence electronics companies within the county, questionnaire results gained for the electronics industry in general

(inclusive of "defence electronics") will be presented. For it became clear that the majority of electronics companies in the survey were, at the most, involved in defence electronics in only a minor form, although equally the employment figures for such firms did not match those of the major defence electronics companies already mentioned.

Hence, 70 questionnaire returns were received from establishments within the S.I.C. electronics group 344 (Activity Headings 3441-4) and Active Components and Electronic Sub-assemblies (Activity Heading 3453). Total employment in 51 of these establishments equalled 5,685, representing an average employment per site of 111 people and highlighting the importance of employment within the electronics sector. Again, over 50% of the establishments were engaged in all the possible "production functions" and no one production function, from R&D to marketing, was carried out in less than 73% of the establishments, highlighting the variety of jobs as well as their numbers. The average date of first year of trading was earlier than that for the whole survey, the respective figure being 1972 in comparison to 1976 as a whole.

However, one major element of the electronics industries has been excluded from the above analysis and that is the computer hardware sector (AH 3302). Although Lovering (1987) has indicated how parts of this sector are involved in defence contracts, such as the Hertfordshire-based firm McDonnell Douglas Information Systems, the sector is predominantly recognised as involved in civil electronics. In terms of Hertfordshire's position as a high technology

agglomeration, the computer industry must also be recognised as having played a dynamic role, a role independent from that of the county's defence electronics sector.

Hertfordshire and the computer industries

In 1981, Hertfordshire had a location quotient of 7-7.5 in electronic computers, a concentration of employment in the county even greater than that of the aerospace industry (see Table 3.4). In the previous decades, just as with the "defence electronics" industry, there had been a stream of continued location of some of the major electronic companies within the county such as GPT (GEC) Computers (1950?), Rank Xerox (1965), Unisys (1966), British Olivetti (mid 60s), I.T.L. (1967), Bull (1970), Eberle GMBH (1972) Digital Equipment Corporation (1975), McDonnell Douglas Information Systems (1977) (questionnaire responses)[68]. Also to locate in Hertfordshire with several sites was Britain's largest indigenous computer corporation, ICL, which was formed in 1968 through a series of mergers and rationalisations.

Between 1975 and 1983 the computer hardware industry nationally exhibited the fastest growth of employment and output of any manufacturing industry in Britain, with its job growth between 1978-84 amounting to 3,759 or 5.5% (Kelly and Keeble,1988,Table 1). Within Hertfordshire, responses from 36 establishments in the industry were

[68] Unisys closed their branch at the end of 1989 and relocated it to their Milton Keynes site. Rank Xerox are in the process of relocating to another of the company's sites in Mitcheldene, Gloucester.

received with 30 of the respondents employing over 5,600 staff, representing an average employment per site of 189 employees. Almost 50% of the sites were branches, divisions or subsidiaries (as against 37% for all sectors) and over 50% of these were foreign-owned yet, for example, R&D was carried out at 76% of the sites as was production and marketing. The average date of establishment equalled that of the whole survey's average, 1976, highlighting a distinct period of development of the computer industry more recent than the county's defence industries. However, this is not the complete story for the other aspect of the computer industry, and integrally linked with the hardware sector, is the software branch. Just as the computer hardware sector experienced employment growth, so between 1974 and 1984 the computer services sector also recorded greater job growth of 13,678 or 69% (Kelly and Keeble,1988,Table 2).

Hall et al. (1987), as was discussed in Chapter Two, only studied high technology manufacturing industries and thus only revealed the concentration of computer hardware manufacturing employment in Hertfordshire. But Howells (1987) has depicted how:

> "...those areas that have specialized in and benefited from computer service activity have been attractive residential localities mainly in southern England. Overall, the South East region had 55.9% of all computer service jobs in Britain in 1981." (op.cit.,p.496)

It was to be expected that Hertfordshire would be one of

the beneficiaries of growth within the computer services industry as a whole and this was duly revealed by the questionnaire survey (and the firm listing on which the survey was based). Interestingly, the survey also revealed the sector as having characteristics distinct from those of the hardware sector.

Firstly, of the 63 respondents, 76% were independents and only a handful foreign-owned. Secondly, the 46 establishments answering the question revealed an employment level of 977, representing average employment per establishment of only 21 people. The largest employment figure was only 130, considerably lower than the average employment figure per establishment for the whole survey of 189, and over two-thirds of computer service establishments employed 20 people or less. Hence, in comparison to the hardware sector, Hertfordshire's computer services sector is predominantly a group of small to medium-sized independents. Interestingly, whilst R&D (61%) and design (59%) were less prevalent production functions than in the computer hardware sector, 92% of establishments were involved in marketing. The sector's growth must also be viewed as a recent phenomenon with the average date of establishment being 1981, compared to 1976 for both the computer hardware sector and the whole survey.

Thus, it is clear that Hertfordshire is a significant location for the computer industries. Moreover, the county has acted as a geographical microcosm of the fundamental corporate and organisational change which has overtaken the British computer industry as a whole, change some would

argue which epitomises an overall structural shift discernible in the British economy.

As Kelly and Keeble (1988) have described, the industry has witnessed internationalisation through the growth in output, employment and market share of foreign owned-multinationals, especially US companies. Secondly, larger indigenous British multi-plant firms have experienced severe problems of uncompetitiveness in this internationalising market leading to rationalisation and job-shedding. Thirdly, the industry has experienced the significant growth, especially since 1975, of new, small and rapidly growing independent firms. New firm formation reached a peak during the period 1965-83 in 1979 when nearly 50 new and currently surviving firms were formed (Keeble and Kelly,1986,p.83). However, the 1980s have also seen a growing number of takeovers and acquisitions of these new independents, particularly by foreign firms. Hence, overall, the industry has witnessed an absolute and relative growth of small, (often) new firms in conjunction with the decline in employment and output share of large multi-plant firms.[69]

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[69] A slight note of caution should be raised for not all the new small establishments are new firms per se. The work of Shutt and Whittington (1987) has already been referred to to show how "fragmentation strategies" have created new small establishments out of larger firms. Howells (1987), for example, has described how:

> "Some of the key computer service and software operations in Europe have arisen out of internal computer service departments which then become subsidiaries, divisions or profit centres embedded within the corporation, or sometimes externalized through a sell-off of management buy-out." (op.cit.,p.498)

Questionnaire results and other evidence confirm the presence of these restructuring processes within Hertfordshire's computer electronics sector and their significant impact on the economic structure of the county. Firstly, ever since the inception of the Garden Cities, the county has been attractive to international firms, and US companies in particular, locating in the South East. The earlier list of multinational electronics companies located in the county can be expanded to include not only US companies such as DEC (1975), McDonnell Douglas Information Systems (1977), Unisys (1966), Rank Xerox (1965), Boeing (1975) and more recently Nantucket (1986), but also a range of European representatives such as Eberle GMBH (1972), British Olivetti (mid 60s) and the Irish company Memory Computer (1989).

Secondly, in plotting the geography of computer manufacturing employment change between 1978-84, Kelly and Keeble (1988,Fig.3) depict:

> "...two main zones of growth in the 1980s, much the more important of which takes the form of a broad western arc or crescent around London from Cambridge to Southampton, centred on Berkshire." (op.cit.,p.8,my emphasis)

However, one county of the "Western Crescent" stands out for its experience of significant job loss over the period, that county being Hertfordshire and that job loss being almost exclusively the result of massive job shedding by ICL, Britain's major indigenous computer manufacturer

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The case study AB is just such an example of an "externalized" internal department.

(now bought out by Fujitsu). Between 1980 and 1985, the company experienced a job loss of over 10,500 employees representing 41% of its 1980 peak workforce. Plant closures occurred in the North West and the North Midlands but redundancies also occurred in Hertfordshire (Kelly and Keeble,1988,p.12). This job loss not only cast a shadow over a generally bouyant local economy but also served to mask the creation of new jobs in a resurgence of new firm formation within the computer industry, both nationally, and within the county.

While Keeble and Kelly (1986) identified peak years of new firm formation in the computer industry as between 1977-80 (op.cit.,Table 4), so Hertfordshire County Council's Annual Monitoring Reports for these years were expressing concerns over the continued development pressure from smaller electronics/computer firms in the county (cf. pp.272-73). Hence, on mapping new computer firm employees and formation rates, Kelly and Keeble (1988) show Hertfordshire as a county of new computer firm employment growth with a new firm formation rate (NFF) over the period 1975-84 of 1.2 compared to the UK average of 0.7. Although in Hertfordshire's case producing a numerically small amount of jobs, nearly 500 approximately, especially compared to greater job loss from one computer firm alone in the county, namely ICL, as Kelly and Keeble (1988) are right to express, the structural significance of this growth of new high technology firms must not be underestimated.

Further evidence of the recent growth of new high

technology firms has been gained from the postal survey of Hertfordshire's computer services sector. Of the 52 respondents indicating their date of establishment, 44 located in the county between the years 1979-89.[70] However, in line with Kelly and Keeble's (1988) findings, several of these have subsequently been taken over, principally by US companies (see also Saxenian,1989). The growth of this small firm high technology sector thus represents the latest chapter in the history of high technology industrial agglomeration in the county of Hertfordshire.

6.3 Hertfordshire: A High Technology Production Agglomeration

Hertfordshire is without doubt one of, if not the, leading high technology counties of Britain. Its prominent position today is, however, based on an extended history of layers of high technology industrial development in the county (see Figure 6.3). Such growth was initially founded upon the growth of aerospace and associated defence electronics industries in the post-war years, and especially centred around a handful of large defence contractors. This high technology ensemble continued to expand with the growth of

[70] Although this figure is for "locations" rather than new firms per se (although the majority of locations were new, small independents) and is biased in that the respondents represented only those firms still located (surviving) in the county, it still represents the significant growth of a small, high technology sector in the county. It should be added that there is a possibility that a few of the firms surveyed by myself were also those surveyed by Kelly and Keeble (1988). However, it is clear that the survey results reinforce the impression gained from Kelly and Keeble's work rather than merely repeating it.

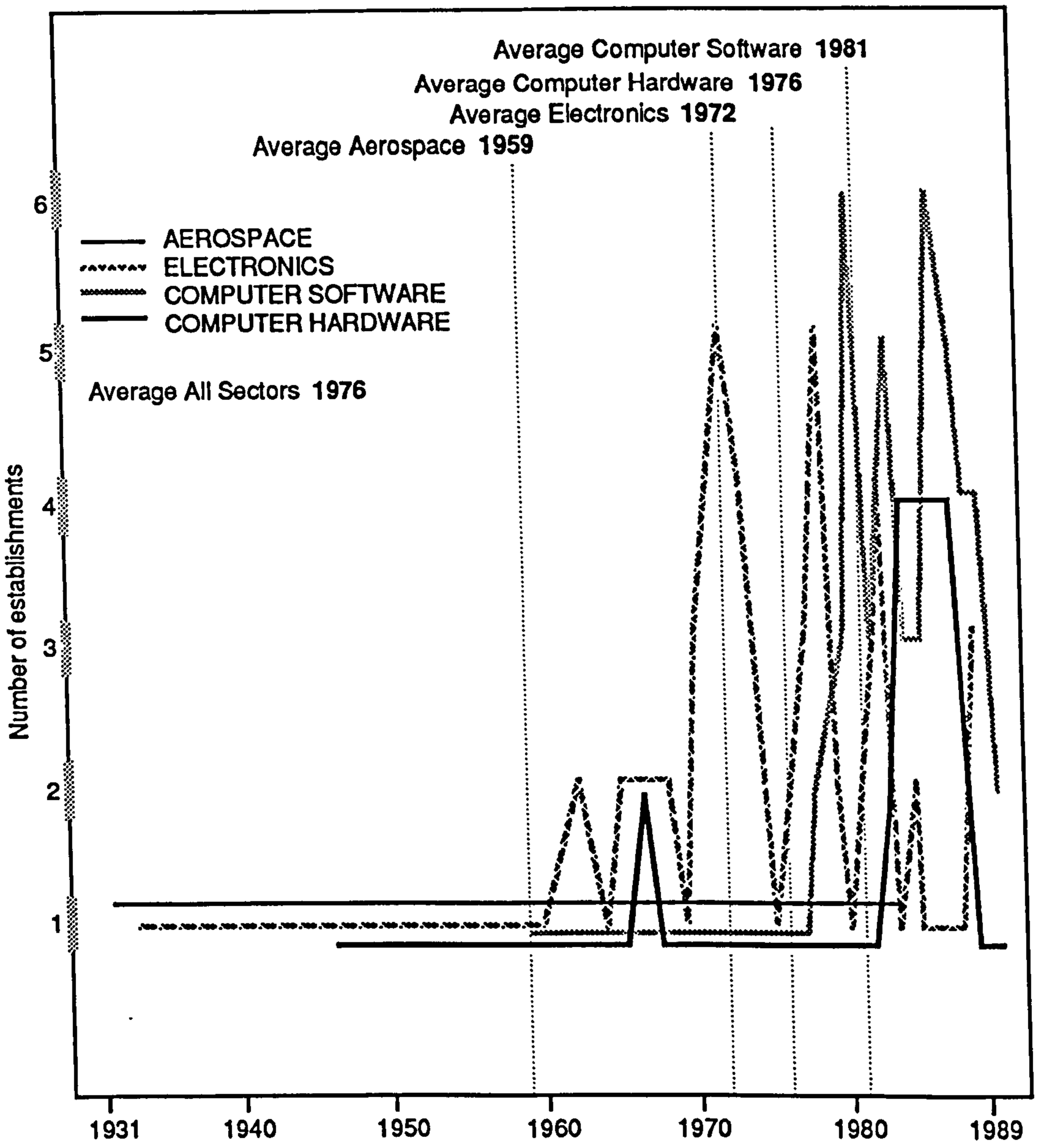

Figure 6.3
High technology Hertfordshire: layers of development 1931-1989

the new pharmaceuticals industry (Rainnie et al.,1988) and the further expansion of the electronics (both defence and consumer) industries, expansion in which foreign multinational investment has played a significant role. Recent years have, however, witnessed a new (third) wave of high technology industrial development in the county based upon the location of a series of new and/or small firms, particularly within the rapidly expanding computer service sector. At the same time, the county's traditional high technology industries have been undergoing a period of restructuring involving a variety of processes including, for example, rationalisation on the one hand and the creation of strategic alliances and joint ventures on the other.[71] Today, the centrality of high technology industry in Hertfordshire's economy is clear. In a postal survey where a mere 133 establishments provided employment figures, total employment exceeded 25,000 giving an average employment figure of approximately 189 workers per establishment. In 1983, 23,000 firms were registered for VAT in Hertfordshire (Rainnie et al.,1988) thus, even assuming that all the surveyed firms were large enough to register (which they were not), less than one hundredth of 1% of a restricted group of high technology firms accounted for between 5-6% of Hertfordshire's employment. Moreover, these establishments represented "nodes" at the top end of the industry's hierarchy. Whilst 80% of establishments included some form of HQ function (63% independent and 18% subsidiaries or divisions[72]), 65% of establishments also

[71] A recent example is the long-running saga of GEC and Siemen's "joint" takeover of Plessey.

[72] Numbers do not exactly tally due to rounding-off.

carried out R&D and just under half carried out all the production functions listed.

Thus, it is to be expected that such a long history of high technology agglomeration in the region will also be reflected in a variety of agglomeration economies.

Other Agglomeration Characteristics

Hertfordshire's high technology "local" labour markets

In Chapter Two it was seen how one common indicator used to define "high technology" industry is the above average employment of professionally qualified engineers, scientists and technologists (PESTS). Also discussed was the evidence provided by Lovering (1987) and Kelly and Keeble (1988) that this group's proportion of high technology employment has been increasing in recent years (see also Lovering,1990b). However, the growth in demand for this key stratum of high technology workers is far in excess of their supply, and an increasingly severe (nationwide) "skills shortage" is being experienced within the "electronics" industry. In 1985, 25% of firms in an Engineering and Industry Training Board (EITB) reported serious difficulties in recruiting graduates (quoted in Rainnie et al.,1989,p.5). By 1987, 50% of an EITB sample reported vacancies for electronics and software staff (quoted in Lovering,1987,p.9). Similarly, the National Computing Centre predicts a shortfall of between 80,000 and 90,000 skilled workers by the mid 90s (quoted in Rainnie et al.,1989,p.5).

The outcome is that these highly qualified and skilled workers have increasingly been able to dictate where they want to work and firms have had to respond to these preferences. Research has identified one of the most prominent characteristics of this social group to be its individual members preference to reside within the rural South East, in other words, the ROSE counties:

> "Electronics companies claim that they cannot attract the kind of people they need to the North, or to urban areas (Boddy, Lovering and Bassett,1986). This is a major reason why high technology is mostly in the South...Employers say they find it easier to attract scarce groups in areas where there are several other potential employers, so employees can avoid becoming dependent on one dominant local company...The shortage of appropriately skilled labour is a major influence on location in the modern defence industry..." (Lovering,1987, p.12)

In a self-reinforcing mechanism the existence of this labour stratum within the rural South East attracts employers which, in turn, attracts this labour stratum. Further evidence suggests that this stratum is also the major origin of new high technology firm founders adding to the employment concentration of high technology within the region (Kelly and Keeble,1986). Thus, within the Western Crescent counties resides Britain's major concentration of scientists, engineers and technicians, a principal source of agglomeration economy for high technology firms and a significant factor in their locational dynamics (Keeble, 1987; Keeble and Gould,1985; Kelly and Keeble,1988;

Lovering,1987; see later also, Table 8.1).

And within the Western Crescent lies Hertfordshire. But the evidence for a "local" high technology labour market within the county, over and above that gained from its position within the Western Crescent, is scarce. This is, however, as much to do with a lack of research on the possibility *per se* than any negative conclusions gained from research investigating such a phenomenon. Ever since the "key worker" policies of the New Towns, and as early as 1966, the County Council have been aware of Hertfordshire's "over-representation" of managerial and professional workers, the county's figure of 22.2% comparing to the England and Wales figure of 15.35% and the South East's 18.6% (Wray et al.,1974). In 1981, almost 10% of the county's 865,000 residents held degrees or professional qualifications, giving the county a "qualifications index" of 138.2 where Great Britain equalled 100 (Estate Times 1.7.1988). However, this figure was partly attributed to the large number of Central London commuters living in the county.

The Training Agency's 1988 County Labour Market Assessment for electrical/electronic and mechanical engineering reported a 50% increase in professional engineers and managers between 1979-1986. In the same year, a further survey for the Training Agency revealed serious recruitment difficulties in the county amid "skill shortages". Indeed, the problem of skill shortages has been a recurrent theme for the county, especially during the 80s. Yet such skill shortages must be treated with care. For, as Rainnie et al.

(1989) point out, these recruitment difficulties covered over 50 job titles and ranged from software engineers to labourers. In other words, a lack of "bodies" (especially young ones) rather than a lack of skills *per se* were behind many of the difficulties.

Nevertheless, in Rainnie et al.'s (1989) investigation of skill shortages in high technology industries in Welwyn/Hatfield, 75% of firms reported problems in recruitment although those problems again included clerical and administrative staff. In other words, problems of "skill shortages" which had nothing to do with the firm's engagement in high technology production. However, the report did find the most acute shortage of workers to be graduate engineers and skilled electrical workers. Yet:

> "It is important to note that in neither case was this viewed as being a national problem. Both cases then are not strictly skill shortages, but rather a regional labour market problem brought about principally by house price differentials."
> (Rainnie et al.,1989,p.12)

Thus, we have a rather confusing picture. Hertfordshire is undoubtedly "blessed" with an over-representation of those key high technology workers who are in short supply. It is clear that such workers also act as a strong magnet of location for the high technology industries. Yet, on location within such labour markets, firms are still being faced with a shortage of such labour and, in turn, a series of **disagglomeration** economies are increasingly apparent. For Rainnie et al.'s (1989) report goes on to describe

widespread practices of staff poaching, a wage price spiral and the impossibility of attracting staff to the area due, principally, to high house prices. Such practices, moreover, are spilling out of the "key worker" stratum to cover a wide range of skills, especially those of clerical and administration staff who have been attracted by the London labour market.

Hertfordshire's high technology "environment"

The county council is acutely aware of the county's high technology economy and policy is geared to its continued growth and success. A Financial Times report described how the council:

> "...is taking steps to attract and secure new industry particularly in the high technology sector. These include electronics, aerospace, research and development, instrument engineering, pharmaceuticals and computer services." (Financial Times 2.4.86)

In alterations to its Structure Plan in 1986, the council put forward a policy for small firm accommodation such that the presumption would be towards giving planning permission for such development, even outside of designated areas. Furthermore, despite a surfeit of industrial land, specific land of a "quality" for "specialised technology" functions was additionally identified (H.C.C.,1986). As part of the Strategy for High Technology, and with visions of the M4 Corridor in mind, the council, in conjunction with a series of districts, has also announced the "A1(M) Corridor"

initiative to attract development to the series of districts straddling the motorway.[73]

Hertfordshire's educational infrastructure is similarly geared up to the needs of local (high technology) industry. Symbolic (in name and action) of this relationship is De Havilland College, one of 12 further education colleges in the county. Major specialisms exist in engineering technology (electronics and robotics) and business data processing. It carries out specialist courses for local industry such as a part-time HNC in software engineering initiated to meet the needs of GEC Avionics, a course which was equipped by local companies including GEC, British Aerospace and Hawker Siddeley amongst others (Financial Times 27.5.1988). The county's showpiece educational institution is, however, Hatfield Polytechnic. In 1986, in a Times Higher Education Supplement poll of Britain's top 500 employers of graduates, Hatfield was the top Polytechnic for both sciences and arts. Science subjects which were highly rated included mechanical engineering, electrical and electronic engineering, chemistry, mathematics, computing and biological sciences (H.C.C,1988). In addition to providing a steady stream of technology graduates, the polytechnic also provides short courses for local industry including, for example, stress engineering and CAD courses for British Aerospace and software engineering and microprocessing courses for Marconi (Financial Times 27.5.1988).

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[73] Further information on the nature and success of this initiative is soon to be forthcoming from Julie Charlesworth of the Local Economy Research Unit, Hatfield Polytechnic.

Hatfield Polytechnic also provides consultancy expertise through "arms-length" firms such as Polyfield Services and Polyfield Electronics. These add to a research and development environment already endowed by institutions such as the world renowned Warren Springs (Industrial Research) Laboratory, the British Standards Institute (BSI) testing facility at Hemel Hempstead and several government research laboratories, not including those research facilities of private companies located in the county such as the Wellcome Foundation, Glaxo, GEC, BAe, ICL, McDonnell Douglas and BICC Technologies to name but a few.

Thus, in conclusion, this chapter provides evidence that Hertfordshire does indeed share some of those characteristics common to the New Industrial Spaces. The county has experienced continued growth of a high technology production ensemble such that it may now be the premier high technology county in Britain. Placed within Britain's major high technology agglomeration of the Western Crescent, and a recipient of the wider agglomeration economies that this inclusion brings with it, high technology growth in the county has most recently involved the proliferation of a variety of new, small, and dynamic firms.

Yet one essential question still remains and, indeed, it is the question raised earlier as pertinent to all the New Industrial Spaces thus far identified. Namely, what exactly are the **causal dynamics** creating the agglomeration characteristics which have just been described. For,

ultimately, it is the causal dynamics of agglomeration which are the definitional bond of the New Industrial Spaces. In Chapter Four those dynamics put forward within the New Industrial Spaces thesis were identified and, in particular, the dynamic of "transaction costs" arising from production linkages concentrated upon. Hence it is evidence of this dynamic, as the most recent dynamic of high technology industrial agglomeration within Hertfordshire, which we must seek in our quest for "High Technology Hertfordshire: A New Industrial Space".

CHAPTER SEVEN: All That Glistens Is Not Gold or Appearances Are Deceptive

7.1 Introduction

The previous chapter has confirmed the importance of high technology industry to Hertfordshire's (and, in turn, the nation's) economy. Possessing the agglomeration characteristics of the New Industrial Spaces, Hertfordshire's outward appearance would seem to substantiate the claim that it is a New Industrial Space. Indeed, evidence similar to that put forward in Chapter Six has been more than enough for other regions' entry into the New Industrial Spaces "elite". However, Chapter Six ended with the argument that **appearance is not enough. Evidence for the causal process(es) driving Hertfordshire's high technology economy is still to be provided and it is only the presentation of such evidence that will allow confirmation (or not) of Hertfordshire as a New Industrial Space.** It is the dynamics of Hertfordshire's high technology industrial growth (and particularly evidence for the "transaction costs" dynamic) which this chapter will address.

7.2 High Technology Hertfordshire: The Dynamics Of Development

The starting point is to recognise that just as specific, and qualitatively different, periods of high technology development can be delineated throughout the county's

recent history, so qualitatively different dynamics to this growth can, similarly, be discerned over the same periods. Historically, the development of high technology industry in the county can be seen to follow the model of "layers of cumulative advantage" (uneven development) suggested by Breheny and McQuaid (1988) for the Western Crescent high technology agglomeration as a whole (see Table 7.1), but with strong local contingencies playing a role.

Hence, Breheny and McQuaid (1988) view the historical origins of the Western Crescent as linked to the development of the electrical industries in West London as early as the 1920s and 30s, although the industries were still heavily concentrated in Greater London at the beginning of the 1950s. This same period witnessed the establishment and growth of the military-industrial complex as firms converted to military production, with Breheny and McQuaid arguing for the significance of this relationship in the subsequent (relative) spatial dispersal of the industries from the 1950s onwards. They describe how many companies' choice of new decentralised locations was influenced by the need for ready access to the Defence Research Establishments, themselves biased in location to the west and south-west of London (op.cit.,p.328-329). In turn, Hertfordshire was also the recipient of two of these research establishments and the centrality of defence spending in the growth and sustenance of Hertfordshire's high technology industry has already been demonstrated, although its role in actual location patterns is possibly less clear-cut than in the Western Crescent more generally.

Table 7.1 The layers of 'cumulative advantage' in the Western Crescent

DATE	1920	1930	1940	1950	1960	1970	1980
EVENT	Development of electrical industry in W. London →		Conversion to military production →	Decentralisation to south and south-west London →		Spawning of small firms westwards →	Continued growth of small firms
		Growth of GRE's west and south west of London →		'Cold war' weapons development →		Growth of electronic weaponry →	Increase in defence equipment budget
			Opening of Heathrow →			Opening of M4, M3, M40 and M25 rail system →	Opening of M25
		Abercrombie's Greater London Plan →	Designation of Bracknell New Town →			Strategic Plan for the South East →	Growth area status
						Influx of U.S. companies →	Growth of U.S. companies
EFFECT	Original high tech concentration		Establishment of local military-ind. complex	Start of planned growth	Major infra-structure boost	Develops as internationally important location	'Western Crescent' recognised

SOURCE: BREHENY AND McQUAID (1988), Table 10.25

The second aspect of the historical origins of the Crescent put forward by Breheny and McQuaid is that of the role of planning policy and infrastructure investment. This aspect may, in contrast, be of even greater relevance when discussing Hertfordshire. The role of Abercrombie's Greater London Plan in the planned decentralisation of London's population and industry to, in particular, New Towns such as Bracknell is particularly highlighted (op.cit.,p.330). Indeed, Begg and Cameron (1988) have further revealed the important correlation between New Towns in non-assisted areas and the location of high technology industry. Hertfordshire acted as a major recipient of this planned decentralisation with the early designation of no less than four New Towns, along with expanded town schemes, and in addition to the garden cities already in existence in the county. The result was an increase in the county's population and employment of over 65% in the twenty years from 1951.

During this period another linked arm of planning policy, Industrial Development Certificates (IDCs), was also in operation and was to prove advantageous to high technology employment in the Crescent, including Hertfordshire. Breheny and McQuaid (1988) describe how:

"The post-world war II 'ceilings' on factory expansion helped push firms or plants short distances (15-50 miles) out of northwest London. In addition, due to their good export record, and possibly because of their importance for defence, electronics companies found it easier than other companies to obtain Industrial

Development Certificates in the prosperous South East and in new towns close to London (Keeble, 1968, 18). To generalise, it could be argued that IDCs pushed what were to become the declining sectors into development areas, while allowing the advanced and future growth sectors to remain in the South East." (op.cit., p.330)

An example of such an occurrence advantageous to Hertfordshire was the expansion of Marconi Avionics described in Chapter Six.[74]

Thirdly, the policy of strict restraint of development, except in designated areas such as the New Towns, to maintain the county's "green mantle" has been the fundamental post-war principle of planning policy in Hertfordshire and no less so, in the Crescent counties more generally. The outcome has been the retention of pleasant "semi-rural" environments, environments which have proved to be particularly attractive both as locations for the new high technology companies and, as suggested earlier, their workforces.

Furthermore, at the same time as various planning policies were combining to help lay the foundations of the uniquely advantageous situation of the Western Crescent today, so other state investment was adding to this advantage.

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[74] Another example is PD:

> "In 1964 our most important customer was based in Tottenham and Cheshunt [Herts] was the nearest place we could obtain [an] IDC. Please note that our largest production unit is now in Ivybridge, Devon because in 1974 we were refused [an] extra gas supply at Cheshunt. Hence [we] were forced to establish a further factory elsewhere." (questionnaire response)

This also represents a clear example of how the state may play a determinate role in the location of industry (whether planned or not).

Breheny and McQuaid (1988) stress the establishment, post-World War II, of Heathrow as the country's major international airport such that, by the 1970s, an influx of US companies had confirmed the Crescent as an internationally important location. At the beginning of the 1970s the M4 was also opened (subsequently giving its name to describe Britain's up and coming high technology region) and in 1976 the first Inter City 125 ran westwards out of Paddington station. Hertfordshire, in turn, has seen its mainline routes electrified and the M25 opened giving access to all the major radial motorways emanating from London. Several of these motorways, such as the M1, A1(M) and M11 already run through the county and further investment for their upgrading has recently been announced. The M25 has also improved access to Heathrow and Gatwick airports whilst nearby Stansted Airport is undergoing expansion as a result of its designation as London's third airport (Observer 3.6.1990).

It is these foundations and continued advantages of the Western Crescent which have proved attractive to high technology industry over a long period of time. Especially significant, however, is the acknowledgement by Breheny and McQuaid (1988) of the recent growth of small high technology firms in the Crescent, starting in the 70s, but continuing throughout the 80s, and coincident with the Western Crescent itself being recognised. It is also this time-period of growth which led to the (M4 Corridor) region being labelled by Scott as a New Industrial Space (Scott,1988a,p.179) and it is this most recent period of

growth upon which the research will particularly focus. For if we are to believe the causal dynamic expressed in the New Industrial Spaces thesis, the most recent period of high technology economic development within Hertfordshire is to be explained by the mechanism of self-reinforcing disintegration and agglomeration. Concomitantly, it is upon the investigation of the causal processes entailed in the county's most recent period of high technology industrial development that confirmation of "High Technology Hertfordshire: New Industrial Space" awaits.

The investigation, however, is two-fold in its aims. For not only is the causal process of Hertfordshire's recent growth "in the dock" to allow judgement of the county's claim to be a New Industrial Space but, the claim for validity of that causal process itself, as **the** force structuring the (post-Fordist) geography of production, is also under scrutiny.

7.3 Production Linkages and The Location Process: A Framework for Analysis

It is at this point that the second aspect of the postal questionnaire becomes relevent. Within Chapter Six results from the questionnaire were used to provide additional evidence for the development of a high technology agglomeration within Hertfordshire. But, as was outlined in Chapter Five, the postal questionnaire was also designed to aid our investigation of the causal dynamics of the pattern of agglomeration it was itself describing.

For we may view each individual establishment which returned the questionnaire as an "outcome". Each establishment is the result of a locational process and, in combination, these establishments make up the phenomenon of high technology industrial agglomeration in Hertfordshire. Hence, the outcomes may in fact be defined as "all high technology establishments within the agglomeration". Within the New Industrial Spaces thesis a causal mechanism (necessary to the structure of the firm) has been described which explains agglomeration. Thus, crudely put, the logic follows that because each outcome (firm) is, by definition, part of an agglomeration, and within the thesis a necessary causal mechanism has been put forward to explain agglomeration, then every firm, by virtue of its "membership" of the agglomeration, has located due to that mechanism. Putting the thesis in a slightly more refined form, because the mechanism operates through external production linkages of firms, production linkages have subsequently been identified between agglomerated firms to provide evidence for the mechanism and its operation. Hence, those outcomes of particular relevance can be re-defined as "all establishments in the agglomeration with 'local' linkages".

Yet, as argued in Chapters Four and Five, such evidence is, in fact, inconclusive concerning the causal mechanism. For the evidence is still only for outcomes (ie. the pattern), even if this set is better defined. We can agree that such outcomes could be expected if the mechanism were to have operated, but we cannot discount that such outcomes could, in fact, be due to another mechanism which creates outcomes

the same as those predicted for the New Industrial Spaces transaction costs mechanism. To put it another way, are the linkages held by such establishments the cause of their location or a result of it?

Thus, the second aspect of the postal questionnaire involved more than just identifying outcomes as "all firms with local production linkages". It also asked a question concerning the locational mechanism of these outcomes. By asking whether or not production linkages did play a part in the location decision, a definition of the outcomes as "all firms with ('local') production linkages which played a role in their location" was achieved. Hence, a group of outcomes identifying not just a pattern but a process of cause and effect was gained. But, although indicating a process, this group still does not explain how that process has operated. At this point, there is no evidence to suggest that the mechanism of the process is that of transaction costs as against any other possibility such as, for example, power relationships. This, as explained in Chapter Five, is the point of entry for the second stage of the research design, the interviewing of selected (case-study) outcomes. Through such interviews investigation of the nature (operation) of the mechanism of the process may be undertaken.

However, before moving to this stage of the research we will return to the results, in terms of outcomes, gained from the postal questionnaire. For whilst the case studies investigated the validity of the causal mechanism as a structuring force in post-Fordist industrial location *per*

se, the postal questionnaire results, first and foremost, delineated whether or not the mechanism had been a major dynamic of the growth of Hertfordshire's high technology industry in particular.

7.4 Linkages and Local Production

The 177 questionnaire returns represented Group A of the outcomes, namely "all establishments located within the agglomeration". The analysis of Group A then followed a sieve process as outlined above. Hence, the next analytical stage involved differentiating members of Group A by whether or not they had production linkages within Hertfordshire. This was (principally, but not solely [see later]) achieved using Question 4 of the questionnaire which asked establishments to note down the locations of their largest two suppliers and largest two customers.

This first stage of the sieving process split Group A into two sub-groups. Group Y representing "all establishments with at least one local (where local was defined as within Hertfordshire) production linkage" and Group N which included all those establishments which did not have any of their four supplier/customer linkages asked for within Hertfordshire. Excluding the 18 establishments which provided insufficient information to allow their classification, Group Y numbered 67 establishments or 42% and Group N numbered 92 establishments or 58% of those eligible members of Group A. Hence, **less than half of the establishments surveyed had a major production linkage within Hertfordshire.**

However, the question remains as to what the above conclusion actually tells us. For whilst this conclusion is a "fact", as with so many facts, the question is what interpretation should be placed upon it. In this particular context, the question we are asking is whether or not the figure of 42% proves or disproves that Hertfordshire is a "localized production system". The immediate problem is, however, that we do not know what the definitional benchmark figure is which allows identification (or not) of a "localized production system". Facing this situation, further analysis of the linkages was undertaken in an attempt to gain greater insight [see Table 7.2 (a),(b) and (c)].

From Table 7.2 it may be seen that **whilst 42% of establishments had a major production linkage within Hertfordshire, only 19% of all the linkages identified were internal to Hertfordshire.** These further figures also allow comparison to be made with other work on production linkage patterns within New Industrial Spaces. Thus, Scott and Mattingly (1989) found that 82.3% of the top 3 supplier linkages of (39) Southern Californian aircraft and parts manufacturing establishments were within Southern California. Similarly, for the Southern Californian electronics industry (33 establishments), Scott and Drayse (forthcoming) discovered that 91.5% of the top 3 subcontractor linkages for each establishment were within the region.

TABLE 7.2 The intra-county "major" production linkages of high technology establishments in Hertfordshire

(a) Supplier Linkages

No. of respondents	177
No. of supplier linkages reported	274
Reported linkages as % of total possible linkages	77%
No. of supplier linkages within Hertfordshire	46
% of reported supplier linkages within Herts.	**17%**

(b) Customer Linkages

No. of respondents	177
No. of customer linkages reported	294
Reported linkages as % of total possible linkages	83%
No. of customer linkages within Hertfordshire	62
% of reported customer linkages within Herts.	**21%**

(c) All Production Linkages

No. of respondents	177
No. of linkages reported	568
Reported linkages as % of total possible linkages	80%
No. of linkages within Hertfordshire	108
% of reported linkages within Hertfordshire	**19%**

Other pieces of work providing some insights into the linkage pattern figures gained for Hertfordshire include work done by Breheny and McQuaid (1988) on the Thames Valley and the work of Gordon (forthcoming). In Breheny and McQuaid's case, they questioned 44 Berkshire electronics companies concerning the advantages and disadvantages of a Thames Valley location. They found that 18% suggested "access to local suppliers" as an advantage whilst 40% pinpointed "access to local customers".

Most recently, Gordon (forthcoming) has carried out a detailed investigation of industrial linkages within a New Industrial Space, the region chosen being none other than the antecedent of the model, Silicon Valley. His research involved the:

> "...systematic study of innovation and the socio-spatial organization of inter-firm linkages in [but also external to] Silicon Valley." (op.cit.,p.3)

Forty firms were questioned about a much broader set of inter-firm "production" linkages than previously taken within Scott's work or, indeed, this piece of research. Furthermore, questions were asked about both the quantitative and qualitative aspects of these linkages. The research produced a variety of spatial patterns of production linkage. For example, sources of capital (excluding the firm's own internal sources) were found to be evenly divided between local (Silicon Valley) and non-local sources. Over 92% of the firms maintained relations with equipment suppliers within the region compared to only

50% which had a relation with suppliers external to the region. In contrast, excluding non-firm supply, 63% of all **principal** component inputs for new product development were sourced outside Silicon Valley.[75] Moreover, local component sourcing was found to be overwhelmingly concentrated in "non-technology intensive inputs" whereas a disproportionate amount of specialized inputs were sourced from outside the region. In the few cases where linkages occurred between firms and academic institutions, such institutions were more likely to be outside Silicon Valley. Over 94% of firms had "external" sales channels and 38% had exclusively external sales, seven times the number of firms with purely local distribution. Yet, where local clients existed they played a more important **qualitative** role with over 47% of firms stressing the importance of local clients in conceptualizing new products.

To combine all these different pieces of empirical evidence provides a rather confusing picture but, if comparison is made between the (major) supplier linkage figures of Scott and Drayse (forthcoming), Scott and Mattingly (1989) and those for Hertfordshire, the concentration of intra-regional **supplier** linkages found within Southern

[75] There is a slight questionmark over this figure concerning Gordon's exclusion of firm supplies. Generally, these are taken as those supplies available from on-site (ie.internal to the firm) such as finance capital, making your own components and knowledge held by individuals. The distinction is an important and useful one but, again, the question of single site and multi site firms is overlooked. The survey sample firms were "predominantly" independent which implies that some may have been multi-site. However, if, as is likely with multi-sites, supplies could be gained by Silicon Valley site's from other company sites outside the region would such supplies be viewed as "externally sourced" or "internal to the firm"? Either way, such "supply linkages" are **qualitatively** different in their nature.

California, at over 80% in both cases, is over four times the figure for Hertfordshire of 17%. However, whilst the figure for Hertfordshire is not directly comparable to the "access to local suppliers" figure of 18% gained by Breheny and McQuaid (1988) in another Western Crescent county, Berkshire, it is of the same dimensions (furthermore, both these studies also found intra-regional customer linkages of greater significance than supplier linkages).

Hence, the initial conclusion to be reached must be that this particular study has found limited evidence that the transaction costs dynamic is realised empirically. If the dynamic does exist, its role as a dynamic of production agglomeration is minor within Hertfordshire. The evidence for "Hertfordshire as a localised production complex" (let alone a complex caused by a particular transaction costs process of agglomeration) is not convincing.

<u>"Comebacks" or caveats</u>

Local linkages: Never mind the quantity, feel the quality

Yet such an interpretation must be treated with care. For this interpretation is based purely on a quantitative assessment of linkages, that is, the percentage to be found "locally". Although Scott's co-authored work on Southern California revealed a dominance of intra-regional linkages in that particular region, such quantitative dominance is not a pre-requisite for the identification of a "localised

production complex". As Scott has stressed (see Chapter Four), if firms are members of a localised production complex it does not imply that all the linkages of such firms are local. Rather, the argument is that such firms will have linkages at a variety of spatial scales, some local and some not, but those which are most "costly" in their upkeep are likely to be local and, indeed, the "localisation" of such linkages is likely to have been the *raison d'etre* of the firm's location in the region. However, such local linkages need not be (and are unlikely to be?) more numerous than linkages outside of the region. Hence, even within the linkage patterns of a "localised production complex", intra-regional linkages may be outnumbered by those external to the region.

Related to this point is the argument that intra-regional linkages are also likely to be of particular significance to only a certain segment of industry (ie.flexible industrial ensembles). In the context of this study, that particular segment is supposedly composed of firms which, amongst other things, are new, small-to-medium-sized, hi-tec and "independent".[76] The point is, however, that such a segment (ensemble) itself may (or need?) not necessarily be dominant within the local economy within which it is to be found.[77] In other words, **the local (high**

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[76] Scare quotes are used to highlight the definition of "independence" for in Scott's eyes this definition would include "branch" sites. Such sites would be presumed to act as if ownership and control were on-site (ie. as independent firms).

[77] Scott and Storper have argued this point concerning flexible production ensembles as a whole (see Chapter Four earlier). That is, these ensembles do not need to be quantitatively dominant within Western production to still exist and be of structural importance. It is less clear, however, whether the implications of this point concerning the quantitative position of such ensembles within New

technology) economy may well contain <u>as part of its structure</u> a flexible ensemble, and hence a localised production complex, but that does not necessarily imply the characterisation of the local economy <u>as</u> a localised production complex. Once again, quantitative analysis of the percentage of local linkages within the "whole" local (high technology) economy could provide a low percentage figure without precluding the possibility of a local production network.

However, it should be noted that such a situation would also ultimately lead to a questioning of the empirical significance of the New Industrial Spaces within the geography of (post-Fordist) production. For if the flexible industrial ensembles constituting local production networks are not even dominant within the New Industrial Spaces themselves and, as argued by the New Industrial Spaces theorists, the flexible industrial ensembles are not quantitatively dominant within (Western) production as a whole, the (qualitative) argument for their structural importance eventually breaks down on the basis of such ensembles/networks sheer empirical insignificance.

In the case of Hertfordshire, the study took a sample of firms defined by their "high technology" production activity alone, and not in conjunction with their size, age, etc. Hence, it could be argued that the result of linkages external to the region outnumbering those internal to the region could be expected. The argument would follow that if a sub-sample of new, small and independent high

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Industrial Space local economies has been addressed.

technology firms was taken (ie. an archetypal flexible industrial ensemble), a higher percentage of intra-regional linkages would be gained. In fact, the results from Hertfordshire lend support to such an argument. Avoiding the problems involved in delineating "new", "small" and "independent" firms, it was found that Group Y (those establishments with linkages in Hertfordshire) was made up of smaller and newer establishments than those establishments comprising the sample as a whole. The average date of birth for Group Y was 1979 with establishments averaging an employment of 38 persons. In contrast, the respective figures for the sample as a whole were 1976 and 190 persons.

However, this merely serves to accentuate the point raised above concerning the actual quantitative significance of the flexible industrial ensembles and the New Industrial Spaces which they constitute. This research looked at high technology firms in Hertfordshire. Earlier, in chapter two, the problems of defining just what is "high technology" were discussed but those sectors chosen for study would commonly be agreed upon by commentators as high technology *"par excellence"*. Moreover, the sectors chosen also represented the core sectors within the definition of a high technology "flexible industrial ensemble" suggested by Scott and Storper (see Chapter Five). Hertfordshire, itself, was similarly chosen as representing part of Britain's premier high technology agglomeration. If the reality of "high technology Hertfordshire" proves to be sectors whose characteristics are at odds with those of the archetypal flexible industrial ensemble (eg. large and old

firms) and as a result only low levels of intra-regional linkages were discovered, this cannot be held up as a criticism of the research. Rather, it serves as a warning of the pitfalls and problems of unguarded generalisation of theoretical concepts (and often definitionally flawed ones at that) from region to region and sector to sector.

The above argument concerning quantitative dominance does have important implications concerning the initial characterisation of Hertfordshire's high technology economy. **For the analysis of linkage patterns above clearly suggests that "localised production" is only playing a minor <u>quantitative</u> role within the county's high technology economy. Hence, it can be concluded that to label high technology Hertfordshire a local production complex is wrong. However, from the previous discussion, it is also clear that it would be a mistake at this stage to dismiss outright the existence of such a complex <u>as part of</u> the county's high technology economy** (especially as a significant minority of firms did have local production linkages).

Just what is "local"?

Just as a possible response to the initial conclusion could be to argue that the high technology industry of Hertfordshire does not actually represent a flexible industrial ensemble, so a similar response could challenge the spatial level of the analysis, based on the definition of "local" taken. For example, Scott's work with Mattingly

and Drayse effectively took the definition of "local" as Southern California. In contrast, it can be argued that to use the administrative county of Hertfordshire to delimit the extent of a production network is to use an essentially arbitrary and **restrictive** boundary.

Work on the New Industrial Spaces is merely the most recent to document that relations of production occur at a variety of spatial scales and are (highly) unlikely to coincide with administrative boundaries. Concerning Hertfordshire, a particular challenge may be made on the basis that high technology industry in the county, rather than acting as a production entity in its own right, is actually part of the wider high technology agglomeration of the Western Crescent. Hence, if we are seeking to identify a spatially delimited production network that search should be undertaken not at the spatial level of Hertfordshire but rather at the level of the "Crescent".

TABLE 7.3 Hertfordshire's high technology industry: A regional geography of its "major" production linkages

	CUS.	SUP.	ALL
South East	62%	60%	61%
- Greater London	29%	13%	21%
- ROSE	33%	47%	40%
Overseas	18%	15%	16%
Each of the remaining UK regions	<4%	<6%	<4%

Table 7.3 outlines a regional geography of the production linkages of Hertfordshire's high technology establishments. Firstly, it shows the total dominance of the South East as the region of high technology production with 61% of **all** the linkages mapped and over 40% of linkages within the ROSE counties.[78] Indeed, at this level of spatial aggregation the percentage of "local" **supplier** linkages, at 60%, moves considerably closer to those figures of 80%+ gained for Southern California. Secondly, the figures for all production linkages highlight that, viewed from high technology establishments in Hertfordshire, the South East is the **only** major region of high technology production within the UK, with over 40% of the remaining (39% of) linkages actually located outside the UK. No other UK region had greater than 4% of all linkages whilst "overseas" accounted for 16%. Thirdly, if the localised production complex took the form of an archetypal industrial district this "overseas" figure could be expected, and read, as evidence of the district's exporting to an international market. Yet it transpired that almost as many of these overseas linkages were supplier linkages (15%) as customer linkages (18%). A final aspect of the figures worth noting is Greater London's particular importance as a market. Whereas 13% of its linkages to Hertfordshire were supplier relationships over twice as many, 29%, were customer linkages.

The regional geography of production linkages shows the

[78] The question is, however, whether or not a similar exercise in Silicon Glen would also reveal a concentration at the level of Scotland or a number of linkages to the South East for example.

clear dominance of the South East region. But Hall et al's (1987) work, which coined the term the Western Crescent, highlighted that the Crescent did not encompass all the counties of the South East. This conclusion was confirmed by an analysis of the geography of production linkages held **within** the South East region (see Table 7.4).

TABLE 7.4 Hertfordshire's high technology industry: A geography of production linkages held within the South East.

	Supplier Links		Customer Links		All Links	
County	No.	%	No.	%	No.	%
Greater London	31	22%	74	46%	105	35%
ROSE	109	78%	86	54%	195	65%
- Hertfordshire	40	29%	43	27%	83	28%
- Berkshire	19	14%	6	4%	25	8%
- Essex	15	11%	6	4%	21	7%
- Buckinghamshire	10	7%	7	4%	17	6%
- Hampshire	7	5%	10	6%	17	6%
- Bedfordshire	7	5%	3	2%	10	3%
- Surrey	3	2%	7	4%	10	3%
- Oxfordshire	3	2%	2	1%	5	2%
- West Sussex	3	2%	2	1%	5	2%
- Kent	2	1%	0	0%	2	1%
- East Sussex	0	0%	0	0%	0	0%
TOTAL	140	100%	160	100%	300	100%

Greater London topped the list with 35% of all the linkages within the South East whilst Hertfordshire, itself, accounted for a further 28% of linkages. The four counties

of Berkshire, Buckinghamshire, Essex and Hampshire each accounted for between 6-8% of linkages leaving the remaining 6 south eastern counties with only 10% of linkages between them. As in the work of Hall et al. (1987), the counties of West Sussex, East Sussex and Kent were effectively excluded from this high technology production agglomeration.

Within the South East region, Greater London dominated customer linkages with 46% of all customer linkages. Hertfordshire followed with 27% and then Hampshire with 6% of south eastern customer linkages. The spatial spread of south eastern supplier linkages was less concentrated with Hertfordshire having the most (29%). Greater London followed with 22%, a value less than half the comparable figure for its' customer linkages, and Berkshire and Essex both achieved double figures of 14% and 11% respectively.

Further evidence for a Western Crescent was revealed by mapping the top 15 "counties" with high technology production linkages to Hertfordshire establishments (see Figure 7.1). Whilst the evidence for a Western Crescent can be seen, with the furthermost south east corner of England totally excluded (as are several M4 Corridor counties), the mapping does provide a more diffuse picture of a Crescent, extending both eastwards and northwards into Essex and Cambridgeshire, Bedfordshire and particularly (Milton Keynes in) Buckinghamshire.

The top 10 destination points of major production linkages

COUNTY	No. of all	% of all
Greater London	105	21
Hertfordshire	83	17
Overseas	81	16
Berkshire	25	5
Essex	21	4
Buckinghamshire and Hampshire	17	3
West Midlands conurbation	15	3
Cambridgeshire	12	2
Bedfordshire and Surrey	10	2

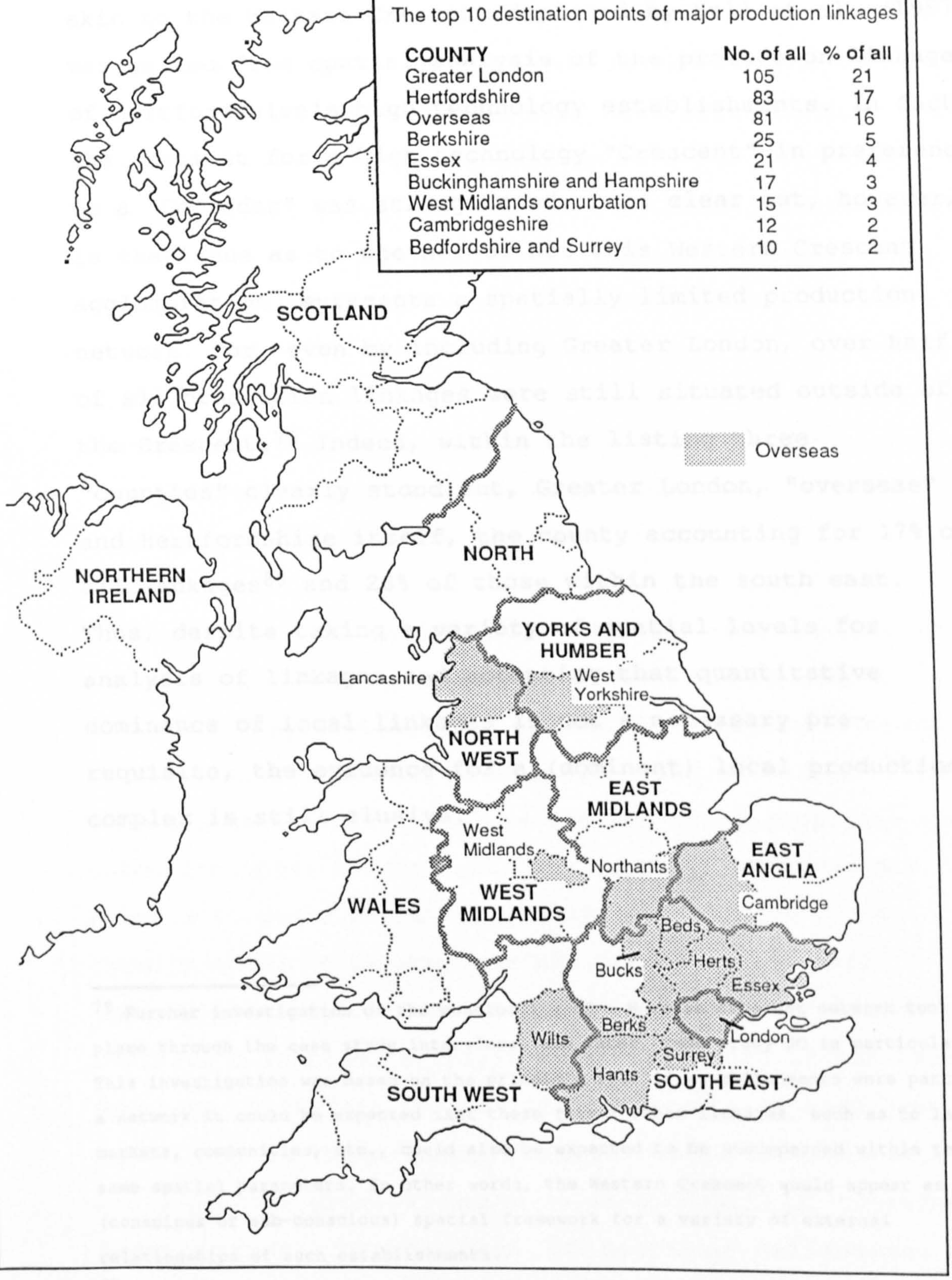

Figure 7.1

Hertfordshire's high technology industry:
a geography of the top fifteen destination points of 'major' production linkages

In summary, evidence for a high technology agglomeration akin to the Western Crescent depicted by Hall et al. (1987) was gained from spatial analysis of the production linkages of Hertfordshire's high technology establishments. In fact, the argument for a high technology "Crescent" in preference to a "Corridor" was strengthened. Less clear cut, however, is the issue as to whether or not this Western Crescent agglomeration represents a spatially limited production network. For, even by including Greater London, over half of all production linkages were still situated outside of the Crescent.[79] Indeed, within the listing three "counties" clearly stood out, Greater London, "overseas" and Hertfordshire itself, the county accounting for 17% of all linkages[80] and 28% of those within the south east. Thus, despite taking a variety of spatial levels for analysis of linkages and accepting that quantitative dominance of local linkages is not a necessary pre-requisite, the evidence for a (dominant) local production complex is still elusive.

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[79] Further investigation of the possibility of a Western Crescent network took place through the case study interviews (see later, case study JO in particular). This investigation was based on the principle that if establishments were part of a network it could be expected that these firms' other linkages, such as to labour markets, communities, etc., could also be expected to be encompassed within the same spatial parameters. In other words, the Western Crescent would appear as a (conscious or sub-conscious) spatial framework for a variety of external relationships of such establishments.

[80] This figure is different to that given in Table 7.2 because whilst it was known whether or not linkages were within Hertfordshire, the "destination" of all the linkages was not known and these linkages were therefore excluded from the mapping exercise.

Production linkages: Does "major" equal "critical"?

A further response to this conclusion can be made on the basis that few local linkages have been found because the research study has actually been looking for the wrong linkages. In other words, "major" suppliers and customers are not the "critical interestablishment linkages" which establishments seek to localise. Rather:

> "This critical range would seem especially to be made up of transactions-intensive (hence high cost) linkages involving above all flexible, rapidly-shifting, small-scale, and non-standard connections between producers." (Scott,1989,p.26)

An initial riposte could be to point out that if this is the case then Scott's co-authored work on Southern California may similarly be flawed. The leading exponents of the transaction costs model also studied "major" linkages defined, by them, as the top three suppliers and subcontractors. However, such a response is inadequate because it would still not explain the difference in results obtained between the two pieces of research. Indeed, the criticism as it stands does not explain the difference in results for it would seem that in the case of Southern California "major" linkages actually have been localised. If the transaction costs model is taken as the cause of this process (which it is by Scott) it therefore implies that, **in the case of Southern California, major linkages do indeed represent critical interestablishment linkages.**

The results for Hertfordshire, in contrast, clearly show that (the **majority** of) "major" production linkages have not been localised. The implication could be, therefore, that in this empirical example, these linkages do not represent "critical interestablishment linkages". In fact, this is only a half-truth, for a significant minority of major linkages (19%) were actually found to be local and thus could be deemed as critical. However, this analysis continues to fall into the (empirical) trap discussed in Chapter Four, namely that a linkage is actually deemed critical or not dependent upon its **spatial characteristic**. In other words, if a linkage is "local" (whether big or small) it is presumed "critical in location" and the mechanism presumed to have operated. In contrast, if a (major) linkage is external to the region, the mechanism is presumed to be non-operational and thus the linkage **not** "critical".

But what must be acknowledged is that linkages are critical, first and foremost, not due to their spatial element but their importance to the production process of the firm: they are linkages "critical in production".[81] This importance may come from a linkage's size, uniqueness, inherent instability, or any combination of these or other characteristics but, moreover, some of these "critical in production" linkages **may also be** "distance sensitive". For example, Scott suggests those linkages which are small-scale, flexible and non-standard. Thus, those linkages which are "distance sensitive" **and** "critical to

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[81] A question to ask is, however, how you decide which aspect of production is "critical" and which is not.

production" then may also become "critical in location". Firms **may** look to locate close to the source of such linkages.

However, an elision (inclusive of a causal mechanism) has occurred in that empirical work which has provided a **pattern** of "local production linkages". For such linkages, by virtue of them being "local", are deemed "critical in production" and thus "critical in location". But, for example, Gordon's (forthcoming) work reveals how local linkages need not be critical in production and thus need not be critical in location. Moreover, putting it the other way, if linkages are "critical in production" then they firstly need not be localised because they may not be distance sensitive or, secondly, the impetus to localise these linkages may be overridden by other production considerations. "Critical interestablishment linkages" is a context-dependent notion. In this investigation, **the context is the location process**; thus we want to identify those linkages **critical in location** and why they are so.

Thus, in this study, the postal questionnaire did actually ask if the production linkages identified by the respondents were critical in their location, even if the question only referred to a particular set of production linkages, namely their two largest suppliers and customers. In addition, however, Question 6 of the questionnaire also allowed respondents to identify other linkages they felt were important to their location (ie.other critical linkages) such as non-major production linkages, local

labour pools or aspects of an industrial community, to name but a few possibilities.

To recap then, the analysis of production linkages can be summarised as revealing that a minority of high technology establishments within Hertfordshire have major local production linkages. Whether or not such local production represents a cohesive network of firms, as part of Hertfordshire's high technology economy, is yet to be determined. We still do not know whether such local linkages are "critical to production" for the establishments concerned. Similarly, evidence as to whether or not such a network of linkages exists at the spatial level of the Western Crescent is also ambiguous. Moreover, the linkage results studied so far do not reveal, firstly, whether or not the linkages identified were also "critical to location" and, secondly, are so due to the locational process of transaction costs suggested by Scott (or, indeed, any other possible mechanism concerned with production linkages). All that is known is that the dynamic can only have played a minor role (in terms of outcomes) in the agglomeration of high technology industry in Hertfordshire.

However, before we turn to investigating "linkages and location", some further comments will be made on the research methodology of linkage analysis used above and the results it obtained. **For the application of the research methodology has given valuable empirical insight into the conceptualisation of the firm and its linkage pattern within the New Industrial**

Spaces thesis, and industrial geography more generally. Just as the argument above has highlighted the context-dependence of "critical linkages" so, in the following, it will be shown how the conceptualisation of a "linkage" itself is a context-dependent process, whether or not the linkage is subsequently deemed to be critical.

7.5 "Empirically-Informed Theoretical Research" (Not Just Theoretically-Informed Empirical Research)!

By referring back to Table 7.2 (c), it may be seen that only 80% of all the possible supplier and customer linkages requested in the survey questionnaire were actually provided by respondents. In fact, considering that the question entailed respondents revealing what could be viewed as commercially sensitive information, especially concerning the names of their largest customers, greater non-disclosure of such linkages could have been expected. Moreover, the response rate gained for customer linkages of 83% was actually higher than that for supplier linkages (77%). Closer inspection of this surprising result revealed a series of "biases" or "issues" implicit within the theoretical conception of the firm and its position within the production process.

Firstly, the greater response rate figure for customers as against suppliers was actually a misleading result. The listing of suppliers gained a reduced response rate because certain respondents argued that they did not actually have any suppliers. The response "we are a service industry

therefore the question does not apply" occurred several times. Such a response does, however, raise the issue of our definition of "supplier" and, more widely, our view of the production process.

Within studies of **manufacturing** industry, "suppliers" have traditionally been identified as a backward linkage in the production process providing, for example, components for assembly or raw materials for transformation. Yet, for certain **service** establishments in this research no such backward linkages existed (or at least not in the form as found within manufacturing). The production of a service was argued to begin at that site. Hence, if such establishments have no supplier linkages this has major implications for a theory of location based on production linkages for, in such cases, it is only through customer linkages that any theorised mechanism can possibly work. In fact, this finding is not so startling, for traditional theories of location for the "service industries" have always stressed their logic of location as being close to the "market".

Yet a response by an establishment that "it does not have any suppliers" needs further consideration on different grounds. For, presumably, what is actually implied is that no suppliers are viewed as integrally connected to the production process of the establishment (they are not critical in production?). The establishment does have "suppliers", such as of stationery and office furniture for example, but these are suppliers which are viewed as "ancillary" (or at least of a different nature). Within the

survey several respondents took this view of certain suppliers and hence, as suggested, did not list any suppliers.[82] However, in other responses, such "ancillary" suppliers were listed as the major suppliers. Thus, respondents named travel agencies, printers, stationery distributers, etc. as well as sub-contractors and components suppliers. Often, such ancillary suppliers were also "local". So, in a quantitative analysis of linkages as carried out above, these linkages assumed an equal importance with local subcontractors; such linkages became part of a local production complex. A question to ask is whether or not this position can be justified. Whilst the provision of such services through these linkages would be readily accepted by many as part of the advantages of agglomeration (and were mentioned as such in several case study interviews), can they also be viewed as key in the production and (hence) location logic of those establishments holding such linkages?

In the past, the answer would probably have been no, based on the principle that service industries were, almost by definition, "ancillary" to the production process. Indeed, the argument would have been that manufacturing firms would not need to locate near to such services but rather, representing the market as they do, services would locate near to them. Interestingly, this could be viewed as a

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[82] Interestingly, the use of recruitment agencies (or internal personnel departments) would traditionally be viewed as just such an "ancillary" service. However, in a "knowledge-based" society where, for example, R&D is now viewed as integral to production, the "supply" of skilled personnel could be viewed as increasingly integral to the production process just as "widgets" were in the past.

"transaction costs dynamic" but for a set of firms called "services" rather than, say, high technology industry. But, and significantly, from the viewpoint of the manufacturing establishments such a dynamic would be part of a **post-location** agglomeration dynamic, in that the arrival of local ancillary services could subsequently lead to the creation of local linkages on the basis of reduced transaction costs. This may represent a **form** (if not actually the exact form) of the "agglomeration causes disintegration" dynamic alluded to by Scott (see Chapter Four). However, a further point to note would be that if purely quantitative evidence of local linkages by such manufacturing establishments was collected and taken as evidence for the transaction costs mechanism, the actual mechanism of causality and direction of causality could be interpreted wrongly. Firstly, differentiation between pre- and post-location linkages could not be made and secondly, interpretation of such linkages as pre-location would suggest their importance in location to manufacturing establishments. Further research might reveal that the creation of such linkages occurred post-location. Moreover, the direction of causality could be reversed in that it is the ancillary services, and not manufacturing, which would be attracted to locate "close" (to the market) to create local linkages. This reaffirms the criticisms made in Chapter Four and highlights again the need to investigate the process of linkage creation and not merely the existence of linkages, to decipher whether or not a linkage is "critical in location".

However, the initial answer that "service" linkages would

necessarily be unimportant concerning production and location may no longer be so clear cut. For whilst it is true that traditional theory has viewed "services" as predominantly ancillary to production within the "basic" industries, more recently the "service" sector has been placed under greater scrutiny with an unbundling of the term taking place (eg. Greenfield,1966; Daniels,1983; Gershuny and Miles,1983; Producer Services Working Party,IBG,1986; Allen,1988; Wood,1991). One line of differentiation has been to identify certain service sectors, labelled the "producer services", by their role as **central elements within the "production process" of manufacturing (and services)**. Such services, just as the traditional component supplier in manufacturing, provide an intermediate input to other producers which is crucial to such producers subsequent ability to produce a product for the end consumer. The point is that such services, just like more traditional suppliers, are an important (critical?) aspect of the production process. In fact, they may possibly be "critical" and "distance sensitive" enough for producers to locate near to them to reduce the spatial costs of such linkages.

The high technology computer services sector represents just one such example of a service industry meeting "intermediate demand", as do certain "business services". It is these service sectors which have also been identified by Scott and Storper as members of "flexible industrial ensembles", prone to the same locational logic of agglomeration more commonly associated with manufacturing industry. The fact that Scott and Storper only (?) include

such "services" is significant because their distinguishing aspect is that of their market or "customer linkages". Whereas the market for services was traditionally the "end consumer" and this represented the customer linkage, the customer linkage for these producer services takes a different form. The customer is part of an intermediate market and only an indirect connection to the end consumer is held. Just as the definition of "supplier" is context-dependent, so too is the definition of "customer".

The context dependence of linkages was also identifiable in other cases where suppliers and customers were not, on the face of it, listed. It was highlighted in Chapter Four that ownership and control relations are essentially omitted from any analysis of linkages within Scott's work. This is achieved by treating all establishments as "independent". However, such treatment proved simply to be unacceptable (inapplicable) within the context of Hertfordshire. For just as "missing" linkages included situations where the respondent believed none existed due to their particular production process, **other linkages were perceived not to exist because they were viewed as "internal" to the firm**. Some of those establishments identifiable as branches and subsidiaries responded to Question 4 of the survey in the following ways:

> "I don't know of any suppliers that supply directly to me"
>
> "All [suppliers] via head office"
>
> "Not meaningful"
>
> "We have no customers as the unit is here to feed into other parts of the company."

Chapter Four discussed the theoretical "reductionism" that has led either to the exclusion from previous analysis of these "internal" production linkages or their inclusion as "external" linkages of "independent" sites. In contrast, the questionnaire used in this research explicitly recognised the existence of such "internal" linkages. Moreover, it recognised that such linkages could actually be local. More than one branch could exist within the locality and production linkages could exist between them. Fundamentally, however, if such a local production linkage (but internal to the firm) could exist, it also implied the possibility that the locational mechanism of transaction costs (within the firm) may also be applicable. And this proved to be the case (see case study JC later). Hence, whilst the existence of branches which are not independent (and the existence of multi-site firms which branches are a part of) is an empirical fact, which it was earlier argued raises serious doubts about the explanatory power of the transactions costs approach in (post) modern industrial times, evidence was gained which suggested that the mechanism may actually be extended to explain the locational behaviour of **some** of these establishments.[83]

Such evidence was available because a further set of linkages exclusive to branches/subsidiaries was identified, separate from those linkages asked for in Question 4. For, as part of Question 1 of the questionnaire, identification of any (not necessarily the largest) production linkage within Hertfordshire between sites of the same firm

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[83] Although it must be noted that the operation of the mechanism in this instance is not due to the "trigger" process of the extension of the social division of labour.

occurred (ie.local 'internal' production linkages). The question identified where any branch was acting as a supplier or customer to another branch **within Hertfordshire**. In fact, from responses to Question 1, 19 branches and subsidiaries (12% of the survey sample and 29% of all branches and subsidiaries surveyed) were identified with other branches within the county. Moreover, 8 (42%) of these held a production linkage with a sister branch.

However, it must be noted that these branch linkages were not the only form of branch linkage identified. As has already been stated, instances where suppliers/customers were listed as HQ etc. under Question 4 were also identifiable. **Furthermore, whilst such linkages were clearly distinguishable as "internal", in other cases this distinction was not made by the respondent.** Hence answers to Question 4 also included names of parent companies and HQ's, sister companies, etc. In other words, the distinction between internal and external suppliers and customers was (empirically) blurred, and thus, as suggested in Chapter Four, also blurred was the (theoretical) distinction to be made between the social and technical division of labour in production, a distinction critical for the New Industrial Spaces thesis. This example serves further to emphasise the point already made of how purely quantitative linkage analysis is problematical as seemingly equal linkages may actually have different meanings.

In summary, the implications raised concerning Scott and Storper's work were that a first step has been taken by

breaking the sectoral classification boundaries and recognising "ensembles" constitutive of both manufacturing and services. Yet our knowledge of the relations and processes of production which occur within such ensembles is still extremely limited, with the use of traditional terminology as suppliers and customers requiring much greater thought and clarification. Essentially, this research showed the context-dependence of such terms. To return to the critique in Chapter Four, qualitative analysis of linkages must also take place to understand the "meaning" placed upon production linkages. That "meaning", itself, is only achieved through understanding the process of linkage creation. And, in the context of the transaction costs model (and thus the New Industrial Spaces thesis), such "meaning" implies **the significance of the process of linkage creation as part of the location process of the firm.**

7.6 Linkages and Location

As outlined in Chapter Five, Question 5 of the questionnaire specifically confronted the issue of linkages and location. It asked whether or not those major production linkages previously identified by each establishment were significant in the establishment's location decision. Furthermore, Question 1, as well as identifying ("internal") linkages between sister branches within the county also asked whether or not these linkages were important in any branch's location. Thus, the questionnaire identified a causal group of "outcomes", a pattern identifying a process of cause and effect.

Excluding two establishments which did not answer Question 5, from 157 respondents **thirty-four establishments or 22% stated that "major" (and/or internal) production linkages were significant in their decision to locate in Hertfordshire.** Hence, these thirty-four establishments stated the operation of a production linkage dynamic of location. Thirty-one identified the importance of "major" production linkages and four the importance of "internal" linkages, thus implying that one branch had both "internal" and "external" production linkages within Hertfordshire which it stated were important in its location.

In summary, if we **assume** that all these establishments represent the operation of the transaction costs causal mechanism and its agglomeration outcomes in Hertfordshire and bear in mind that it is the alleged existence of this dynamic which defines a New Industrial Space, the results confirm that high technology Hertfordshire cannot be viewed as a New Industrial Space although, **subsumed within the local high technology economy,** elements of a New Industrial Space **may** exist.

<u>The group of "31+4": A closer examination</u>

A characteristic outcome?

Members of this group all stated that production linkages were important to their locational decision. A first question to ask was whether or not this group of outcomes

also held particular common characteristics. For example, Scott's work had highlighted size, age and "independence" of establishments as of particular importance in differentiating firms responding to the transaction costs dynamic. Were these outcomes different from those establishments in the sample as a whole concerning these or other particular characteristics? Alternatively, was there a characteristic common to them all, such as age or size? Did they represent a common outcome attributable to the mechanism?

Within the group of 34 sites all the sectors in the sample were represented, led by the Computer Services (8394) sector with 11 sites and Electronic Data Processing (3302) with a further 8 representatives. Even with such small sample numbers, there were no extreme variations from each sector's proportion of the returns as a whole. The split by ownership also closely mirrored that of the respondents as a whole, the figures for independents being 65% and 63% respectively. In fact, such a finding could be interpreted as supporting Scott's assumption that ownership plays an insignificant part in the mechanism with branches behaving the same as independents. From the 27 sites which provided an employment figure, the total number employed was 3,362 representing an average employment per site of 138 persons, compared to the respondents employment average as a whole of 189 persons. The range was large, however (just as in the respondent group as a whole), stretching from 1 to 2,250 persons employed. Removal of this top figure reduced the average employment per site to 42 persons but the range was still from 1 to 360 persons employed. The average date

of set-up was 1980, four years later than the average for all respondents, whilst the range of set-up dates stretched from 1963 to several sites established in 1988 and 1989.

In summary, whilst the members of the group of "31+4" were slightly younger and smaller than the whole respondent body, this study confirmed the conclusion also reached by Gordon (forthcoming) in his work on Silicon Valley: that firm characteristics such as age, numbers employed, ownership, sector, etc., did not reveal a particularly cohesive "set" of establishments or, indeed, a typical firm which would be a representative outcome of the locational dynamic of transaction costs agglomeration. In contrast, what was striking about this group of outcomes was their variety concerning such characteristics. In fact, **whilst the study had identified a better defined set of possible outcomes of the transaction costs mechanism (by asking whether linkages actually played a role in location), this had resulted in a set of outcomes of greater, not less, variety (including a multi-site form not previously identified).** The implication is that any attempt to suggest the existence of the transaction costs mechanism on the basis of a consistent set of "similar" establishments is likely to fail. For what bonds such a (causal) group of establishments, and may precisely link, for example, large and small firms alike, is their shared process of location and not their similarity of firm "characteristic".

Identifying the mechanism of the process

Yet, at this point, we still do not know exactly what form of location process this is. Or rather we know that it is a process driven by production linkages but we do not know how it works. Scott suggests the process works through the transaction costs of a particular set of "flexible" linkages and provides a theoretical explanation of how this would be so. But, as yet, we have no evidence which raises this particular explanation of the workings of the mechanism above other possibilities. The means to gaining an answer are, however, clear. Firstly, by recognising that what binds these outcomes is the role of their production linkages in the locational decision (ie.the process), then our analysis should be based on identifying exactly what are those linkages which are so "critical" to these establishments location. Secondly, once the properties of these linkages have been identified, exactly how these linkages relate to the constitution of the establishment and its location can be investigated. In other words, the nature of the mechanism and its operation.

Continuing the analysis along the lines indicated above involved the use of two different sources of information. Firstly, there were the returns from the postal questionnaire detailing the "firm characteristics" of the site, the site's production linkages and the importance of these linkages and other factors in the site's location. These returns enabled the identification of the form of linkage "critical" to the establishment's location. Secondly, in order to investigate the operation of the

mechanism through particular critical linkage relationships, selected case studies were undertaken.

The case studies involved a visit to the establishment site and semi-structured interviewing of the questionnaire respondent or a nominated proxy of similar standing within the company.[84] Firstly, the interview involved a more detailed and wide-ranging discussion and explanation of the questionnaire response given by the establishment. Thus initial questions concerned the company's foundation, history, ownership, financial relationships with other firms, products, etc. The process of actual location of the site within Hertfordshire was also probed. All (and not just major) supplier and customer relationships of the site such as where they were located, whether large or small, specialist or standard, etc., and, in particular, the role of distance in such relationships, were discussed in detail. Furthermore, the interview continued with a discussion of all those other elements argued by the New Industrial Spaces thesis as part of any agglomeration dynamic. Thus, questions were asked concerning other less formal linkages or forms of co-operation with other companies and private and public institutions, whether local or not, held by the establishment and the concept of the "industry in the air" was also raised. Fundamentally, a prolonged discussion concerning the relevance of the establishment's location in (high technology) Hertfordshire took place. A discussion which investigated both positive and negative aspects of this location for the establishment and included a hypothesised scenario in which the company

[84] See Appendix at end of chapter for a copy of the contact letter (Figure 7.2) and interview schedule (Figure 7.3).

would be forced to leave the county.

Whilst 13 case study interviews were undertaken, 19 establishments were actually approached for interview. Of those 6 not interviewed, 2 refusals were received, one point blank and one citing heavy workload as the company had just gained one of the biggest orders in its history. Two further respondents agreed in principle to an interview but due to lack of time, heavy work pressures, etc., these interviews were never carried out. Of the remaining two establishments approached, one simply had "gone away" since completing the questionnaire leaving no obvious trace. The final establishment was a subsidiary which was taken-over between the time of the survey and follow-up interviewing. The respondent (the Managing Director) had since left the company.

However, prior to the interviewing of case study establishments (and the reason why they were chosen; see individual accounts below), the identification of (forms of) production linkages "critical in location" needed to be undertaken.

<u>"Critical" production linkages</u>

The computer services company **KV**, set up in 1985, only had one major production linkage in Hertfordshire which was a supplier linkage. In addition, however, it identified its other major supplier, McDonnell Douglas, as being less than 10 miles away in Bedfordshire and furthermore, the company

listed "local suppliers" as a key factor to the establishment's location in Hertfordshire. In this case, the role of **local supplier relationships** in the location process seemed to be undeniable and it is this aspect of the company which led to its further choice as a case study.

Another company with both its major suppliers in Hertfordshire was the small computer electronics firm, **KA**, which also set up in the mid-80s. In addition, one of its major customers was also Hertfordshire-based, thus three of the company's four major production linkages were in Hertfordshire. As a new, small, independent high technology company with local production linkages an immediate hypothesis was whether or not this company was part of an industrial district. Yet this is not the complete story told by the questionnaire response. Firstly, **KA**'s major Hertfordshire customer was not another small firm but Rank Xerox, a major US multinational electronics firm. Whilst the size of this company may not actually be relevant dependent on the definition of an "industrial district" taken, it is true to say that the canonical industrial district does not have any multinational players within its ranks.[85] The issue of size is raised here because of its common use as a proxy for **power** within firm relationships.

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[85] Sabel (1989), in particular, does argue that this may be changing with multinationals deliberately locating within districts to gain from these small production networks. However, in the case of Rank Xerox, the site located in Hertfordshire in 1965 and now employs 1500 people. Its particular location was due to taking over the existing premises of another subsidiary, Rank Bush Murphy. Moreover, this site is about to be relocated to Mitcheldene in Gloucester (postal questionnaire return).

As was outlined in Chapter Four, the property of power, as well as spatial cost, is similarly intrinsic to any linkage and, moreover, the power distribution between partners in a relationship is fundamental to the form of that relationship and, possibly, its spatial structure (Storper and Harrison,1990). Concerning the particular relationship between Rank Xerox and **KA**, it could have been, for example, a relationship of equal partnership or **KA** as dependent subcontractor of Rank Xerox. **In both cases, a local production linkage may be determining the location of KA but the implications of the two are significantly different.** In the former, the concept of the industrial district may not be violated although the connection is with a major multinational. This connection could even be viewed as the connection of the district to the international market. In the latter situation, although the pattern suggests an industrial district, the reality is different. **KA** is dependent on Rank Xerox. In turn, both of **KA**'s major **local** suppliers may be dependent upon it. Hence, the "industrial district" is not a production network with a flattened hierarchy but rather a network of dependent suppliers and subcontractors whose future is tied in to, and determined by, that of a major multinational. This reality may be no different from past historical industrial concentrations of the steel, car and ship-building industries amongst others. The history of rapid decline of such regions is also a reality, as is the imminent move of Rank Xerox out of Hertfordshire. Thus, this raises the question of whether we are looking at what some commentators describe as the future path of economic development or a possible repetition of the past with all

its inherent problems.[86]

Secondly, the original assumption that these three linkages are the "critical" relationships, **because they are local**, may also be wrong. For the company's second largest customer was London-based and when describing the most important factors in its location the respondent listed "close to London" (ie.not Hertfordshire). An implication from this could be that Hertfordshire may well be supplier to, and part of, a **London-based** production complex. If we stand by the view that it is the spatial property of a linkage which determines its importance in the location process, then this finding suggests that any definition of "local" should be on a spatial scale inclusive of London and Hertfordshire (see further discussion below).

Thirdly, however, the firm's location in Watford was stated, first and foremost, as due to the Managing Director's **place of residence** being Watford. This response raised further queries. For if residence is the basis of the firm's location decision, then what role in location could production linkages have played? However, if one questions whether or not it is mere coincidence that

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[86] In fact, the future may hold a new variant of this (past) dependent industrial district. For many major global companies are now pursuing the goal of reduced numbers of suppliers through single-sourcing and other strategies. One case study establishment which supplied Ford of Detroit described the company's wish to have less than 100 parts suppliers. This meant that the particular case study company in question, although at present a supplier of Ford's, would no longer necessarily be able to deal directly with Ford. Rather, it would be forced to deal with one of the "100" who were able to provide a number of different parts, possibly in the form of sub-assemblies, to Ford despite the likelihood that such a company would be a direct competitor. The spatial repercussions and forms of "industrial district" arising from such policies may be varied if not unfathomable!

this company set up in computer electronics within a region regarded as at the core of such industry, then a role may be found. For it may be that the knowledge of, or potential for, production linkages in Hertfordshire was the catalyst for the firm's creation to begin with. Such an instance would fit the dynamic of continued extension of the social division of labour and agglomeration described within the New Industrial Spaces thesis.

In fact, **ALS** may have exemplified just such an instance. This data processing company set up in 1966 and also stated residential location as the initial reason for its Hertfordshire location. However, in following the thinking as to why, in particular, a data processing company should be set up in the region, the respondent also noted as location factors the:

> "...pool of supplier expertise and subcontractors all at the leading edge of technology and methods - [and there being] enough of them! [And the] availability of workforce expertise from existing industry." (postal questionnaire response)

So it is clear from the example of **KA** that a variety of interpretations of the operation of the causal mechanism, with differing implications for the nature of the "outcome", is possible from the pattern of linkages outlined. **However, without knowledge of the process of creation of such linkages no single interpretation can be prioritised.** Despite the company resembling the archetypal "small firm in an industrial district", the operation of the causal mechanism of its

location and its actual membership of an industrial district was still unknown and it is on this basis that it was chosen as a case study.

Another company in the group, V, had both its major suppliers in Hertfordshire. Yet these supplier relationships, on closer inspection, transpired to be with a travel agency and an office furniture supplier (ie.non-critical). To return to the earlier discussion on the definition of suppliers, these could be taken as "ancillary" suppliers not unique to Hertfordshire. Or rather these suppliers were unlikely to be a specialist service present due to the concentration of **high technology** industry, rather than industry *per se*, within the area. In turn, it was unlikely that these supplier linkages determined the location of V in Hertfordshire **despite their being "local" in nature.** V's major customers were specialist space agencies in London and West Germany and thus "convenience to the motorway networks and the airports" was its major location factor.

However, the fact that the company's ancillary supplier relationships were internal to Hertfordshire may also not have been coincidental. The advantages of proximity of such services to clients is a known factor in the creation of such linkages. Hence, it may well be that this is an example of the transaction costs mechanism and its agglomeration dynamic in that V's choice of (ancillary) suppliers was locally based. But, highlighting an earlier discussion in this Chapter and Chapter Four, such linkages are created post-location and hence the dynamic of

agglomeration is of a different form, for it is a **derived dynamic**. Crucially, this dynamic is a result of the primary growth of high technology industry in the region and not a self-sustaining dynamic in its own right. The supplier linkages identified were in Hertfordshire and part of the agglomeration of Hertfordshire but they gave a false picture of local production. These linkages were not "high technology production" linkages and part of the high technology dynamic but were, in reality, dependent upon that dynamic. Such **local** linkages were "red herrings" in explaining the firm's location.

Company **Q** further served to highlight the dangers of prioritising linkages in analysis purely due to their spatial pattern (ie.in this case being in Hertfordshire). For the linkages important to this company's location were not those it held internal to Hertfordshire but its customer linkages, which were external to Hertfordshire. Its local supplier linkage was with a stationers. In contrast, its customer linkages were with City institutions in Central London.[87] Hence, "easy access to Central London" and "cheaper and pleasanter than Central London" were two of its location factors.

A further point to make concerning both **V** and **Q** is that their location factors (derived from their customer linkages) were not unique to Hertfordshire. "Access to Central London and/or the airports" could equally be achieved by locating in Berkshire or Surrey for example.

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[87] Thus highlighting a process of cumulative growth as two "flexible industrial ensembles", high technology and business services, coalesce.

Hertfordshire's high-technology economy gained from its position as part of a London-based production complex (eg.the City), and a production linkage dynamic was acting in these instances, but these firms' location in Hertfordshire as against say Berkshire was due to other contingent factors. Thus, in Q's case, the first location factor listed was the owners/directors' residence in Hertfordshire.

This scenario similarly applied, at an even greater spatial scale, to the electronic data processing subsidiary **DIL.** This was an acquisition still headed by the founders, who were living within Hertfordshire when they set up the company in the county in 1980. Its major suppliers were global chip manufacturers supplying through "agents" but its customers were banks and building societies headquartered in London. Proximity to "major clients in London" was listed secondary to residence as the most important location factor.

Another electronics company, **SCS**, also listed both its largest customers as City institutions. However, it was supplied (with circuitry) by a Hertfordshire company and its other supplier was STC in Harlow (Essex), which the questionnaire survey revealed to be a leading supplier of components to Hertfordshire's high technology industry, as well as a customer in several cases. In turn, this raised the possibility of STC acting as node to a production network which included Hertfordshire, although the spatial extent of such a network and the role of distance, if any, within it is a matter of conjecture. The possible role of

major companies as core entities of a production complex (or the "market") has already been hinted at, particularly concerning **KA**'s link with Rank Xerox. It will be returned to later in reference to Hertfordshire's major high technology employer, British Aerospace.

However, to return to the suggestion that Hertfordshire is, in fact, supplier to London-based markets such as the City and it is the spatial aspect of these customer linkages which are important to location, other examples of London-based markets were also evident. Hence **AB**, a further case study, had no linkages in Hertfordshire but had both its major customer linkages with London-based (but national) architects and thus listed its major location factor as Hertfordshire being near to London. Similarly, **PDE** citing the "push" factors of a London location, had relocated into Hertfordshire but with the knowledge that it remained near to its major customer located in London. Furthermore, consistent with the growing literature on the role of defence expenditure in (the south east's) regional development (Lovering,1985; Markusen and Bloch,1985; Breheny,1987; Hall et al.,1987, Lovering and Boddy,1988) **MIL** stressed that "MOD central purchasing was Whitehall" and Hertfordshire was "close to London for meeting MOD and foreign clients [United States Armed Forces]". Thus, Hertfordshire represented a location providing spatial proximity to (a variety of forms of) the "market".

Further forms, which also exemplified the importance of ownership and control linkages and their inter-relationship with production linkages, were depicted by the branches

within the group of outcomes. **CML**, a computer bureau owned by one of the nationalised industries, located a branch in Hertfordshire in 1986. The branch employs 3 people. Its HQ was in Staffordshire and its function as a branch was purely that of "marketing" its services. Hence, customer linkages were integral to its existence and, in turn, its location. However, Hertfordshire alone did not represent the market but rather, as the company stated:

> "The bulk of our new business is generated in the South-East, therefore Watford, Herts. is an ideal base for a sales team to work from." (postal questionnaire return)

In other words, Hertfordshire was important for its strategic position as giving access to the South East. A similar example was **JO**, also a branch set up in 1986. However, in this case, Hertfordshire was strategically located as it provided the ability for the branch:

> "To effectively cover our marketplace of the Northern Home Counties & M4 Corridor." (postal questionnaire return)

In addition, this outcome effectively identified the Western Crescent as a discrete entity, providing possible evidence for an production complex at that spatial scale. To investigate this possibility, **JO** was chosen as a case study. Also distinguishing these examples was the fact that the locational mechanism **had** to work through their customer linkages. For both of them stated that they had no suppliers, in part determined by their functioning as branches.

CML was a "part-process" site (Massey,1984) carrying out what is traditionally viewed as the downstream end of production, namely marketing. So also did **DEQC**, a branch of a major US multinational electronics company with several branches and an HQ within the UK. This particular branch, set up in 1975 and employing 360 people, was solely engaged in marketing with no supplier linkages listed. The branch **ALA** undertook production, marketing and liaison with customers such that its Hertfordshire location provided:

> "Good communications and transport with easy links to HQ and [the] majority of customers [the major ones being in London, Hitchin and Northampton]." (postal questionnaire response)

All its supplies were, however, via head office in Norfolk. Thus, this set of outcomes highlighted instances where other linkages of the establishment, namely ownership and control, determined in some form or other the establishment's function, subsequent production linkages and hence the operation of the locational mechanism. In so doing, they highlighted the already discussed problems of equating branches with independent establishments. In particular, this equation also excluded the possibility of branch establishments which had "internal" production linkages within Hertfordshire which played a role in their location.

APCSL, a subsidiary formed in 1972, is one such example. Set up within the same building as a fellow subsidiary, it shared the facilities and other advantages from such an

arrangement as bulk-buying and the cross-over of staff expertise. However, the most important location factor listed was the:

> "Close link with fellow subsidiary AP whose customer base is around Hertfordshire."

In addition, the establishment also argued for the importance of Hertfordshire giving access to its own supplier and customer linkages.

In the case of **JC**, an R&D branch employing 65 people, it was the fact that a fellow Hertfordshire branch **was its major customer** which dictated its location in Hertfordshire in 1988 (and its choice as a case study). The original Hertfordshire branch, employing 250 people, had only located within the county in 1984. With no major production linkages in Hertfordshire and these linkages playing no role in its location, the establishment listed access to airports, London and other routes and the ability to attract highly skilled staff as its location factors. In addition, however, and in stark contradiction to its fellow branch, it was also stated that the fact that none other of the company's numerous branches were located within Hertfordshire:

> "...was important as we wished to stress our independence & 'stand alone' nature." (postal questionnaire response)

JC represented a situation where the "market" was internal to the company and hence, coincidentally, internal to

Hertfordshire. In similar vein it was earlier suggested that the market could actually represent one major (external) firm (which happened to be?) located in Hertfordshire. Within Hertfordshire the major firm is undeniably BAe.

Thus **FOL**, involved in the fibre optics industry, was set up in Stevenage in 1982 and employed 8 people. With no major suppliers in Hertfordshire its customers were the MOD and BAe, Stevenage. The question remained as to whether it was an independent small firm or a dependent supplier/subcontractor.

MD proved a fascinating example of the role of customer linkages in location. This was a branch of a US multinational headquartered in Los Angeles and employing thousands in the US. Located in Hatfield in 1985, this branch employed 3 persons. Its major suppliers were external to Hertfordshire and it named only one major customer, BAe at Hatfield, which it cited as the **only reason** for its location in Hertfordshire. Moreover, work for BAe had been carried out in the US since 1982 and hence before the branch's establishment in Hatfield. Whilst this site's location was undeniably due to its relationship with BAe, without knowledge of the process of linkage creation the exact workings of the mechanism were still a mystery. For example, was the branch set up to liaise on existing contracts or to gain more and hence, was its location based on the insistence of the customer, BAe, or a decision by the supplier? In which direction was the causal mechanism working? But, however the mechanism worked, it was working

over a vast geographical distance and between two major multinationals rather than two "family firms within an industrial district". This company proved a compelling choice of case study.

Whilst major company sites located in Hertfordshire, and hence Hertfordshire, represented **the** "market" for the latter establishments discussed above, none of the examples of outcomes so far discussed actually involved a conception of the market which would create linkage patterns typical if an "industrial district" existed: namely, other small high technology firms within Hertfordshire. Possible examples of such firms did exist however in the "outcomes" group.

GLC, set up in 1980, could be viewed as the firm closest to the heart of the New Industrial Spaces theorists. For this was a one person printed circuit board manufacturer based in Letchworth with his major supplier and customer also in the town. In turn, the firm's location factors were "business local to customers" and "lived locally".

KD, employing 36 and located in Welwyn Garden City, also appeared to be an undoubted example of the process of disintegration and agglomeration depicted by the theory. Both its largest customers were located within Hertfordshire, the largest actually within Welwyn Garden City. Its location was stated as due to the need to **retain** its labour force. This paradoxical location factor was explained by the fact that the company was a "planned" spin-off, in 1977, of another Welwyn Garden City company

founded in its original form in 1937. A further unplanned spin-off from this original company proved to be none other than KD's largest customer. Other returns from the questionnaire survey confirmed that KD was actually only one of several planned spin-offs, all located within Welwyn Garden City with common shareholders and directors. Hence, KD also became the subject of further study.

Summary

One of the most surprising elements of the group of "31+4" (those establishments who stated that production linkages had played a role in their location) was that over a third of the establishments did not have a major production linkage in Hertfordshire. Furthermore, in some cases (such as "ancillary" suppliers) where a major linkage internal to the county was held, this linkage proved not to be the "critical" linkage in the establishment's location decision. Firstly, this illustrated the earlier argument about the danger of prioritising a linkage simply because it was "local" in nature (that is, fitted the definition of local taken). Knowledge of the spatial characteristic of a linkage, even a linkage identified as part of a local production network, is not enough to ascribe locational causality to that linkage. However, the research had been deliberately designed such that, in these cases, it was known that particular linkages identified were "critical in location". Thus, the diversity of "spatial length" of these linkages revealed that the production linkage process of location, although grounded in Hertfordshire, was operating at a variety of

spatial scales. Put another way, "local meant different things to different people".

Moreover, the process was operating through a variety of production linkages, both supplier and customer, both external and internal (ie.within multi-site firms). Finally, in all these cases, the question still remained as to whether or not it was the transaction costs mechanism driving the location process. In other words, was the "distance sensitive" nature of these linkages or some other linkage property driving the process? Answering this question involved moving to the case study stage of the research but, prior to this, important preliminary conclusions could be drawn about the agglomeration pattern known as "high technology Hertfordshire".

"High technology Hertfordshire": Some preliminary conclusions

It is clear from studying the group of "31+4", only just over a fifth of the respondents, that **high technology Hertfordshire is, in fact, constituted by a variety of combined and overlapping high technology production complexes.** Examples of such complexes include the multinational and its "local" suppliers, whether these suppliers are themselves multinationals or part of one of several small firm production networks (so are these all industrial districts?); a variety of London-based production complexes such as that focussed on the City; the Western Crescent complex; and internationalised defence and aerospace production increasingly guaranteed through inter-

firm collaboration. Moreover, complexes based on a derived dynamic of agglomeration may also be discerned, as the presence of such a high technology agglomeration has acted as a market for a series of further (locally-based) "high technology" and "ancillary" services.

Together these complexes constitute the "high technology Hertfordshire" production agglomeration but, from the evidence of "major" production linkages, **not a tightly integrated production network.** To that extent, high technology Hertfordshire represents an aggregate, "a group of distinct things gathered into a whole". Yet these establishments, signifying a variety of production complexes, also represent a causal group, for these establishments all share a location dynamic based on their production linkages. However, the lack of an integrated production network implies that, in contrast to the theory of the New Industrial Spaces, that dynamic is only in a minor way **driven by a localised production network.** Rather, the dynamic is operating at a variety of spatial scales which include Hertfordshire in their dimensions. Exactly how the dynamic is operating was revealed through the case studies.

7.7 Case Studies of the "31+4": The Mechanism of Location

As outlined earlier, the case studies were chosen to investigate the operation of the process in particular instances. The investigation was based on deciphering the

role of transaction costs within the mechanism of location and, from the outcomes depicted above, several establishments **appeared** to be characteristic of "small firms in an industrial district". Thus, examples of these were chosen as case study "archetypes" for investigation of the transaction costs mechanism *per se* and wider investigation of the possibility of a "high technology industrial district" in Hertfordshire. As may be recalled from earlier analysis, such a possibility had not been ruled out, merely the fact that if such a district existed it was a quantitatively minor aspect to the county's high technology economy.

Case Study KA: *"I don't know but I know a man (sic) who can"*

Firstly, there was the company **KA**, with three of its four production linkages within Hertfordshire. The exact role of such linkages in its creation/location was still uncertain however, since **KA**'s major location factor had been suggested to be the founder's residence. The process of creation of the company and its production linkages needed to be revealed.

In a classic example of "disintegration cum agglomeration", it became clear that it was no coincidence that this computer electronics company had been set up in the core region for such industry. The founder (and interviewee) had previously worked for several major electronics companies in the county and, whilst with one of these companies, he had become aware of a major (local) competitor who needed

support for a particular product. Thus, in 1984, he set up **KA** at his home in Watford to provide support in the form of test programmes and diagnostic software. **It was the knowledge of a potential local production linkage that was the key to the company's creation.**

At the same time, the founder was also aware that situated in Watford he was in the core of a high technology region, which he described as "Britain's Silicon Valley":

> "Northern home counties is a beautiful location."
>
> "There is six-ton of electronic businesses both small and large in this area." (personal interview)

The respondent's conception of a high technology region was also held at the spatial scale of Hertfordshire and even the business park on which the company was located. In fact, **KA** was the first tenant of a park which was suggested to be 90% electronics-based companies. The view of a high technology production agglomeration was further confirmed by the company's supplier base. Its two major suppliers were both located in Hertfordshire and this similarly proved to be no coincidence. One of these companies was actually an individual with whom the founder had previously worked, and it was this knowledge of key people and companies and **the fact that they were local** which were the critical properties to supplier linkages:

> "We sub out work. Who do I sub out work to? People I know, companies I know. Invariably I am going to know local companies and I'm going to know local guys [sic]. And because they are local

it's probably why I'm going to do it."

"Yes, yes. The game I am in is talent orientated. I've got a pool of local engineers who will either work weekends, work evenings... or on contract and they come in here and like they hover from company to company. Local! That's very true, very true. If I've got a big contract in, the size of us, what I'd have to do is sub it out to those who are competent. Those who I knew I could give the job to. Yes, I've got that resource, that's why we are here."

Why local suppliers?

"Geographical location sticks out, because he's just round the corner!"

KA was part of, and gained from, a local specialist high technology production network. It included both major and/or specialist suppliers and, furthermore, such linkages were greater than tightly defined production linkages. Both formal and informal "linkages of co-operation" existed with local companies:

"That happens all the time. Yes with small local businesses, yes with big companies. A classic one, I wanted a logic analyser. I can't afford one. Rank Xerox [second largest customer] have got one. I go to Rank Xerox, my friend there, and say listen man, can I borrow a logic analyser. Yes, sure man, it's collecting dust here at the moment, we're not using it."

Another example also involved a token financial investment by **KA** in a company in the (adjoining) county of Bedfordshire. The company had set up at a similar time and

both were still surviving but the relationship was not, in reality, based on finance:

> "A beautiful, mutual symbiotic relationship! Very complementary. He wasn't in my area of the market, I wasn't in his but they overlapped. We worked together. Yes, I made him rich because I introduced him to Telecom".
>
> "[The relationship is an] intellectual relationship. Intellectual property. In our game, electronics, your biggest asset is your staff and your knowledge. If you have got talent you're laughing. If you know talent you're laughing. If you know talent and you're capable of talking to talent you are laughing. So what we do is we pool each others' knowledge. I've got a particular area, a problem on. Ah, I've come across this before, this is what you do. I don't know, I know a man who can!"

It was clear that **KA** tied into a **local** high technology production network in terms described within the New Industrial Spaces thesis. It could be considered as part of an "industrial district" (driven by large firm customers). Indeed, when asked what the company would most miss if forced to move from the area the answer was:

> "I'd miss my talent, my contacts, my local contacts. The sort of company we're in I need talent and I need local talent."

The point to make, however, is that, prior to the interview, **KA**'s membership of such a district was questionable as **KA**'s customers are, predominantly, major electronics/telecommunications companies. Its (post-Fordist?) relationships with these customers, highlighted

by its ability to borrow specialised and expensive equipment from one of them (see above) transpired to be far removed from the "dependent subcontractor" typology. However, that distinction could not be made from the identification of a "local" linkage alone.

Case Study KD: *The family of firms*

The process of disintegration and agglomeration in Hertfordshire was also exhibited by the example of KD. The origin of the company stemmed from DEV of Welwyn Garden City, set up in 1937. This company provided colour sorting equipment for the food industry but, during the fifties, realised that the product's future was bleak. Therefore, the company began talks with a team from AEI, a major medical electronics company, which itself was undergoing a restructuring process. The result was the creation of an instruments section within DEV, manufacturing electro-cardiograph recorders and led by a team previously employed at AEI. The subsequent success of this product switch eventually made DEV the target of a buy-out by an American multinational. However, the buyer was only interested in certain parts (products) of the company such that the demise of DEV led to two further spin-offs, C and D.

Subsequently, in 1972, a company called RMD of Hertford became one of D's major customers. This company was, in turn, historically associated for it was an earlier spin-off from DEV led by an ex-sales manager of the now defunct DEV implants division. RMD, in collaboration with Edinburgh Royal Infirmary and an innovative doctor in the US, had

created a new and advanced body monitoring system. It was knowledge of the people who had previously worked at DEV which led the company to turn to them, and therefore the spin-offs they now ran, to manufacture various parts of this system.

However, it was in the late 1970s that the disintegration process really took of. In 1977, a further series of "planned" spin-offs from D and C, itself in financial difficulties, occurred. A "manufacturing arm" KD was created led by the previous works manager of D, and D and RMD subsequently became the major customers of KD. Other spin-offs also occurred led by members of the original team from AEI who had joined DEV. In 1977, OR was formed to manufacture pen chart recorders for body monitoring systems by the engineer of the original AEI team. In 1978, FI was formed by the team's mechanical engineer. It produces precision engineered components for, in particular, medical electronic devices. In 1980, TE was created to manufacture tape recorders for the body monitoring system of RMD. This company, in turn, was led by an original draughtsman of the team. **Finally, one other aspect also linked these companies together, they all located in Welwyn Garden City.**

But other spin-offs have not done so. The original managing director of DEV, after selling the company, moved to Jersey. Subsequently, a manufacturing arm of the group was set-up in Jersey. LE, a manufacturing arm of OR led by an apprentice from D, is also located on an industrial site at the airport, whilst a further sales arm is based in Jersey,

led by the son of DEV's ex-managing director. Thus, the "Hertfordshire Handful" have exhibited a vigorous disintegration process similar to that identified as integral to the origins of Silicon Valley (ie.the Shockley Eight) and the Cambridge Phenomenon.

However, there are subtle but important differences. To take the case of KD, it is an electronics sub-contractor with 80% of its business tied up with RMD. It does not have a product in its own right and the firm network described above is primarily based on the production of a particular product for RMD. RMD have recently announced their intention to take production in-house which, ultimately, will leave this group of small firms without a product.[88] The response of KD has been to seek work elsewhere and its nature as a sub-contractor has implied the search principally involving approaching other large companies requiring subcontract work to be done. Whilst the firm network may well stay intact through ownership linkages the suggestion is that the nature of the network is undergoing change away from networked production linkages. Interestingly, an alternative strategy, based on what has been learnt from the work on industrial districts, would be

[88] This (particular) turn of events goes against the general trend of disintegration of production argued for by Scott and Storper. Interestingly, the respondent suspected that the logic of RMD was based on its hopes to go public in the near future. Despite its international reputation as a design and marketing organisation, fears were held that its non-involvement in any form of manufacturing may be viewed negatively. The point is that this represents an example of a production strategy far removed from any account of transaction costs and their role in integration or disintegration of production. Indeed, it could be taken as a further example of the oft-quoted complaint that the financial considerations of the City take precedence in the strategies of our industrial companies.

collaboration between the firms to create a product. Indeed, considering their history of close association and the "dynamism" argued for within such small firm networks it may be viewed as significant that this strategy has been ignored in favour of a continued large firm subcontractor role.

Secondly, the spatial concentration of the production network within Hertfordshire, and even Welwyn Garden City, was broken through the creation of spin-offs in Jersey. What precipitated this, however, was the residential move of a key person. If the transaction costs mechanism was present it was "over-ruled" by a key linkage of, effectively, skilled labour. An individual moved to Jersey and despite the presence of a complete family of firms within Welwyn Garden City and a wider high technology agglomeration of Hertfordshire and beyond, and the presumed transactional cost advantages of such a situation, a subsequent "sponsored spin-off" was set up in Jersey on the basis of this individual's move. Indeed, the importance of skilled labour was supported by the only location factors expressed by KD and the other spin-offs who responded to the questionnaire. Hence, OR stressed the presence of an established labour force and KD the need to retain key people.

The possible advantages of location within a high technology agglomeration were subsequently discussed with KD and provided some further interesting insights, as well as a possible explanation for its future business strategy. Firstly, the question of a local supplier base was raised.

Neither of KD's major suppliers was based in Hertfordshire (although one was in an adjoining county) but the location of these particular linkages was viewed as unimportant:

> "RR were not selected because they were local, Bedford's just down the road. They were selected by our buyer largely because of the good deal she could get."

This good deal involved competitive prices, extra time to pay, good service, etc. Distance did not play a significant part in these linkages but, interestingly, this may have been explained by the fact that all the major components suppliers employed **local representatives and hence overcame any notion of distance:**

> "We've selected them because of the deal they've offered rather than their location. Location with suppliers just really doesn't matter very much... All these companies have their own local rep. who you are dealing with so it doesn't really matter where the components are stocked and made up and posted from. That doesn't really come in to it very much."

Thus, whilst the concept of "local" may indeed be important in production, as Scott suggests the type of linkage held with suppliers is highly relevant. For in the case of KD its major suppliers overcame the requirement of "proximity" by the supplier maintaining a local presence without actually being located in the area. The locational mechanism of transaction costs could be overcome or at least severely curtailed in its impulses by such a strategy (for particular supplies).

In contrast, KD was also aware of, and heavily used, local suppliers for one-off bits of manufacturing. The local area did supply a specialist and large pool of suppliers and subcontractors:

> "In fact, because the electronics industry is, I think, predominant in the south eastern corner of England... Hertfordshire... has a very large electronics manufacturing contingency. So you know what happens, the ancillary industries build up in the area don't they. One of the problems of moving somewhere else is that that doesn't exist."
>
> "[There is a specialist pool of subcontractors] that has grown up around the industry because there are some very large electronic manufacturing companies here... Of course, the support industries grow around them and we have the use of them."
>
> "The basic reason they are here is because they can get work, there is work here. And the bulk of the work comes from these very large multinational companies and I think that companies like KD, I think we would have difficulty finding people with these specialist skills if some of the big boys [sic] weren't in the area."

However, the support industries used by KD (which the respondent argued included not only high technology subcontractors but also other ancillary services such as courier deliveries) were viewed as derived from the presence of large multinationals, not any small firm production network. This point was confirmed on discussion of the concept of "high technology industry being in the air":

"If there is an atmosphere about Hertfordshire which is associated with electronics, I've never really felt it, I've never noticed it. I think that is something that is beginning to blur into what we were talking about earlier. That industry develops around those one or two very large giants in the electronics field. Now it may be nice to say that there is a lovely atmosphere in the air but if you took those four or five majors and moved them to the middle of Cheshire, I think you'd find that the atmosphere followed them very quickly."

KD's description of high technology agglomeration was not that of a small firm production network but rather a large firm subcontracting network. In fact, the presence of large firms caused KD severe problems of labour shortage due to poaching by these firms. This had led the company to consider relocation, with South Humberside highly favoured (including by the key personnel). Questioned on the loss of contact with local suppliers it was suggested that South Humberside was a good choice because recently one or two large electronics companies had located in the region. Just as a supplier base had been built around the electronics multinationals of Hertfordshire so a similar situation would be taking place in South Humberside. Such suppliers would, in turn, be of use to KD. Moreover, the increased distance between KD and its customers was not seen as problematical. Thus, the suggestion was of little, if anything apart from inertia, tying the company to Hertfordshire despite its recognised agglomeration advantages. Again, the transaction costs advantages might be "overcome", in this case through

particular problems of labour recruitment which had raised the possibility of relocation. The difference of outcome between **KD** and the previous example of **KA** was striking.

Case Study KV: *The specialist labour spin-off*

If it is the presence of multi-national companies which is the driving force of the growth of high technology in Hertfordshire, this force took a variety of forms including the classic disintegration mechanism of firm spin-off. **KV** was a spin-off from McDonnell Douglas, located only 10 miles away, and its major supplier linkage. The founders had previously been selling McDonnell Douglas hardware to large government organisations, in particular, the MOD. However, a repeated request from clients for software engineers and contractors had seen them set up their own business to meet this demand along with that for bespoke software.

The first people **KV** employed were predominantly previous McDonnell Douglas employees and the hardware they used was McDonnell Douglas. Indeed, McDonnell Douglas itself became a customer. Interestingly, their first offices were also rented from another local electronics company, itself a contact from a previous relationship when working at McDonnell Douglas. "Local suppliers" were listed as an important location factor and it transpired that "supplies" in this case, as with **KA**, principally meant "talent".

It was revealed that **KV** was involved in a web of informal agreements with other **local**, small software houses. These

were based on sharing resources, principally people. A company could take on work and "front" it whilst calling on the skills of employees of other firms. Indeed, it was not unknown for such labour to be included in employment statistics when dealing with clients! At other times, when work was slack, employees would similarly be offered to other firms. The most striking aspect about this local labour market, however, was further informal agreements not to poach staff. This went as far as informing other firms if they were approached by employees of such companies. The respondent argued that these practices **had to be local due to their informal nature.** Indeed, a formal joint venture between **KV** and another local software house had ended in failure. The "costs" of being local in this case were simply the ability or inability to create flexible and informal linkages critical to the company's survival. In turn, the company **was** tied in to the region by the residential locations of its founders and "staff" ie. the local labour market.

However, such a situation was changing for the company itself was undergoing a transformation. The provision of software engineers on contract was a high risk business which the company was moving away from. Instead, it was engaged in the creation of "products", combined hardware and software packages to then sell. This, in turn, meant that it was deliberately pulling out of the informal networks it had been part of. For, in order to protect such products, confidentiality was of utmost importance and those companies whose staff had previously been used on an ad hoc basis now represented competitors, not co-workers.

Hence, Hertfordshire as a local supplier base was increasingly irrelevant especially as McDonnell Douglas, still a major supplier of hardware, had now moved to Woking.

Case Study AB: *"It makes no difference at all"*

In the case of **AB**, which exemplified a further form of "spin-off", the role of transaction costs in the location mechanism was minimal. The origin of the company was its creation as a computer department in 1974/5 within the major London-based architectural practice, GMWP. Its major product is C.A.D. systems, initially for architectural practices but increasingly for design departments of major retailers. The department grew so big that in 1980 a subsidiary company, GMWC, was created and in 1985/86 a partial management buy-out occurred and the company was renamed **AB**. It now employs 60 people.

AB's location in Hertfordshire in 1980 was based, firstly, on the fact that the senior staff assigned to the new subsidiary, whose jobs had previously been located in London, predominantly lived in Hertfordshire. Secondly, GMWP had an outpost office in Hertfordshire and for a time this office was shared. Thirdly, Hertfordshire provided access to the top UK architectural practices based in London, including GMWP which is still the largest customer. This was the critical production linkage in **AB**'s general location but it was not critical to **AB**'s specific location in Hertfordshire.

Discussion of the role of distance in the company's major supplier linkages with firms in Milton Keynes and Bristol, possibly signifying a high-tech agglomeration on the basis of the Western Crescent/M4 Corridor, elicited the response:

> "It makes no difference at all...It's the companies as opposed to where they are based."

Similarly, concerning the possibility of a specialist supplier base in Hertfordshire:

> "There is nothing that we use which we couldn't find elsewhere. And I could state it the other way around. There is very little that we buy locally that we buy because it is local."
> "We are much more interested in the product that is produced than the fact that they [the supplier] are just around the corner. Our market is worldwide and therefore our selection of suppliers is worldwide as well."

However, despite the move into a worldwide market, the major market was architectural practices and major retailers headquarters which were predominantly located in London and the South East. Thus, the continued need for proximity to the market and principally London was stressed by AB and, moreover, this proximity was argued as the only positive aspect to the company's present location in Hertfordshire. **Thus, despite the company's high technology product, AB's location had little to do with high technology and its agglomeration within Hertfordshire. Rather, Hertfordshire gave access to a London-based market.**[89]

It may be argued that some form of transaction costs mechanism was operating in this need for proximity. However, such a form would seem to be merely a restatement of the traditional spatial pull (location factor) of the market. It is clear that no transaction costs mechanism based on the emergent production logic of local flexible supplier linkages was present.

Case Study JO: *A derived dynamic of high technology?*

In contrast, Hertfordshire and its strategic position as central within the high technology agglomeration of the Western Crescent was the market for the branch, **JO**. This company, the UK market leader with 8 branches nationwide, specialised in the provision of technical human resources to the computer industry, both contract and permanent staff. The computer industry, by their definition, included data processing installations for retailers, financial organisations,etc., as well as the electronics and defence industries *per se*. Its presence highlighted the derived dynamic of agglomeration raised earlier. For the respondent emphasised the fact that the company "reacted to the market" and "set up here because the others are here." They responded to the client's perceived need for a local presence:

"If you are in a service industry I guess your clients want to be

---

[89] **AB** did go on to argue, however, that time would see this requirement decline:

> "Distance is important but, in fact, we as a company are making it less important. When we made the decision two years ago to go international we had to develop ways in which from [Hertfordshire] we could support around the world. And by doing that we also enable ourselves to support people in the UK more easily, remotely."

> able to reach out and touch you or hit you or congratulate you or whatever."

Again, the critical production linkage was that of proximity to the market (and not the requirement for a specialist supplier base) but in this case the market was inclusive of **high technology Hertfordshire**. Thus:

> "The only reason we would move from Hertfordshire is if there was no longer an industry [ie.market] here we could serve. As long as there is business for us to do here we would stay here. [However,] if they all moved, we'd go as well."

Case Study MD: *Transaction costs - transatlantic and to your door*

As we learnt earlier, the **only reason** for MD's location in Hertfordshire was its customer link with BAe Hatfield. Indeed, in the interview the respondent stated that the company had had no knowledge whatsoever of Hertfordshire when it located in the county in 1985. MD's Hatfield branch employs 3 people whilst the division as a whole employs about 1,000 with sites in San Diego, Irvine and Los Angeles. The division provides technical documentation, principally a parts cataloguing service, for the aerospace industry.[90] MD had been providing this service for several years to BAe, whose engineers inputted parts specifications onto punch cards or magnetic tape which were then sent to

[90] On average, a single airplane consists of about 80 million parts and due to continual development, maintenance and safety reviews no one plane is ever the same. To create a parts list is a major and skilled operation.

the US to be catalogued by MD. On a visit to one of these US sites, representatives of BAe were shown MD's on-line input computer systems and subsequently asked for this service to be provided in their Hatfield site. Thus, MD set up a branch site at Hatfield to undertake this task. To maintain its independence (the branch also deals with minor enquiries from other european aircraft manufacturers), MD declined the offer to locate at BAe Hatfield but set up less than 3 miles from the site and still within Hatfield. For MD this location provided a physical presence allowing (the often required) daily contact with the customer, including the ability to "problem-solve" any difficulties with the on-line system.[91] As an example of the ability to identify the actual cost of particular transactions, the branch also deliberately situated within the same telephone exchange as BAe. This was important because the host computer at the branch has 5 communication links to the BAe site, rented at £250-300 each line per year. To move out of the telephone exchange district (just a few miles) would see the cost of each line jump to approximately £2000!

The site principally acts as nothing more than a "data capture" site, with information sent to the US to be processed. Yet this process is increasingly being viewed as problematical, in terms of delay and complications, such that MD has been considering setting up a local data processing, as well as capture, facility. In other words, despite the technological capability to create and use an international division of labour, a transaction costs mechanism has been operating to create pressure for

[91] In an interesting twist to the creation of production networks, MD is now fitting this system into BAe's subcontractors.

"agglomeration". But, and confirming the need for particular conditions to be met for the mechanism to operate **to produce agglomeration**, the company has not succumbed to these pressures. The principal reason is that, despite a history of aerospace in the area (eg. De Havilland located in Hatfield in 1934) and technical documentation activities within BAe, a severe lack of skilled labour has meant that the company has been unable thus far to advance its plans. Thus, the mechanism was operative concerning the original location of MD. Indeed, it operated over a vast geographical distance and between two major multinational companies. However, it has subsequently been overridden by "other production considerations". Moreover, it has been overridden by a lack of skilled labour, whereas the growth of such a labour market would be an expected key element of any (New Industrial Space) agglomeration.

Case Study JC: *The branch linkage*

The final case study of the group of "31+4" investigated the process's operation within a multi-site firm. JC, employing 65 people, located in the county in 1988. It is the R&D branch for the "technologies" group, itself comprised of nine divisions yet, in turn, one of only five main operating groups of a leading British engineering company. As outlined earlier, (all) JC's customers are other divisions of the company with which it has "market" relations as JC has its own operating account. What it does not have is a trading account and thus no customers outside of the company. One of these other divisions and a

major customer is another branch in Hertfordshire and regular exchange of personnel and information both formally (costed) and informally takes place. Furthermore, it was this "customer linkage" which was integral to JC's location in Hertfordshire:

> "But Hemel Hempstead in particular, historically it's close to X [other branch]. There is this interchange that's going on here."

Thus, the transaction costs mechanism was found to be working within a multi-site firm structure. However, it should be added that the respondent also argued that the branch was actually totally divorced from high technology production going on within the county. Its customers were internal and its major suppliers worldwide.

This point was further investigated after outlining the concept of the "industrial districts" to the respondent, and the arguments of Sabel (1989), amongst others, that multinationals are now keen to be part of such phenomena. Sabel's argument that decentralising multi-nationals are looking to locate units within districts was particularly significant in the context that JC was one of several "decentralised" R&D sites created with the break-up of the company's central R&D site in West London. However, just as with JC, these other "centres of excellence" located at or near existing production sites. The possibility of JC's location in order to integrate into a local high technology supplier base was viewed as irrelevant on two counts. Firstly, a questioning of exactly what Hertfordshire could offer as a high technology agglomeration and secondly, the

ethos of the company anyway and, thus, the likelihood of its taking advantage of such a situation.

> "I know [the] M4 Corridor has a reputation for electronics supply. I know the back-end of Edinburgh and Glasgow, particularly Edinburgh... Yes, if I was say a disc-drive manufacturer I'd want to be close to all the sources of supply for those special little widgets that I needed to make the disc drive work. But I don't think that's the case with where we are at the moment, I'm pretty certain of saying that."

In fact, of particular interest was the respondent's view as to exactly what high technology in Hemel Hempstead is all about, especially as the estate on which the company is based is one of the largest industrial estates in Hertfordshire, boasting a who's who of high technology companies. The respondent argued:

> "These buildings are like tombstones. This is what the whole thing amounts to, you know, prestigious new development for Y. Y is doing very well. Look at what they are doing, look at how much they are building. And in 5 years time that site will be empty, or it will be leased off to some other company or it will be hived into business units and rented off. We've got a classic emporium here in Hemel. The Z building... the "Emerald Palace"! That is absolutely the epitome of the present British industrial rise of Hemel Hempstead. Go to Hemel Hempstead and build a bloody great palace. That's exactly what they've done. Its more to say, [to] signify how well they are doing as a corporate giant...But its a very different culture from the one you've proposed about this small network type configuration."

The reality of the company's impact on the locality was:

> "We impinge locally on the community by being here. But, yes we have needs, we have the fact that we need a catering service, we need somebody to come and do the gardens and wash the windows. But we do not support a little infrastructure of small [high technology supplier] companies..."
>
> "I don't think we would participate from the way the business is structured. Whatever we do is done very much with costs in mind, purely business relationships... we couldn't have this flexible working arrangement. It's totally different."

Rather, the future strategy of the company lay in its internationalisation through global networks:

> "That does go on. Those are very important. No underrating those. Those strategic alliances are such that they really dictate the future of organisations like JC. It is the international acquisitions and the international nature of business now that those are really the key building blocks of a strategic plan for something like JC. Getting into North America, acquisition of companies in Europe...They are building market share, they're being competitive through economy of scale...Very strategic, very long term, very international. There's no part of the globe which seems to be quiet and unaffected by this."

Yet the respondent could still see the logic of the transaction costs mechanism:

> "Wherever there's regular meetings, progress reviews and

deliverables that are going back and forwards, its by far and away best to have somebody on your doorstep if you've got it, if you know about them. I'm not disputing the fact that logically it should be done! However, the driving force has always seemed to be, the objective is, to produce the widget. But looking at the saving and the cost and the sensible attitude of 'let's go and look on Kings Langley [local] industrial estate' or 'let's go and look at something nearby'... it's not part of the rationale here for some reason, as I said before. It should be done and it could be done if there was a higher profile given to it. If we were hit with regular newsletters from the Hertfordshire Chamber of Commerce or some august body that says, 'hey, look, do you know what's on this estate'. Even a newsletter for this estate. It's a vast estate."

Thus, in the most telling of comments, the respondent concluded that:

"We've had great industrial centres like Manchester and Liverpool but there has been communities in those places and I think that is what is sorely lacking now. Simply for the reason that we no longer talk to anybody in this road. This is an industrial estate, we are an industrial company. But it would be alien if we were to go across and talk to McDonnell Douglas about a communications problem."

JC's location was partly the result of a transaction costs mechanism operating "internally". However, the operation of that mechanism externally, to impinge upon the local economy, was clearly not a consideration. In effect, rather than a branch exhibiting the "cathedral in the desert"

syndrome, JC could be seen as a "cathedral in an oasis".

Concluding remarks

Thus, case studies of members of the group of "31+4" reveal a wide variety of instances where major production linkages are important in the location process. However, this production linkage dynamic is as much to do with "access to the market" as the need for the "just round the corner specialist supplier". The market itself may be "high technology industry in Hertfordshire", and thus indicative of cumulative growth, but in other instances the characteristic of being "high technology" and/or "located in Hertfordshire" were incidental in the creation of the production linkage.

What is most striking about the production linkage dynamic of location is the **variety of outcome** gained. Whilst location in Hertfordshire was the result, the articulation of the establishment into "high technology Hertfordshire", if it occurred at all, occurred in a series of forms, only some of which were critical to the continued well-being of the establishment. Thus, the picture of high technology Hertfordshire revealed is that of a complicated combination and overlapping of production complexes exhibiting a wide range of structural relations to the local economy.

However, there is one further aspect to this picture; its **partiality**. For this picture is based upon the respondent group of "31+4", a group which represents less than one-quarter of the questionnaire respondents. Thus, whilst a

detailed and intricate analysis of the principal location mechanism of the New Industrial Spaces has been carried out in this chapter (so fulfilling the major aim of the research), only a minor part of the agglomeration high technology Hertfordshire has been explained. In the following chapter further explanations for this agglomeration, arising from analysis of the remaining questionnaire returns, will be discussed.

FIGURE 7.2: CONTACT LETTER

The Open University
Walton Hall
Milton Keynes
MK7 6AA

Telephone (0908) 274066
Direct Line (0908) 65
Telex 825061
Fax (0908) 653744

Faculty of Social Sciences

September 1990

Dear ,

You may recall that several months ago you kindly completed a "Hertfordshire Establishments" postal questionnaire as part of my research into the concentration of high technology industry in Hertfordshire.

As explained then, the postal questionnaire was the first stage of a research project aimed, in particular, at describing and explaining the production and ownership linkages establishments have with each other, especially within Hertfordshire, and the role of such linkages in location. The second stage of this project involves more detailed interviewing of selected firms along with local organisations such as the Chamber of Commerce, County and District Councils etc.

Following an unprecedented response rate to the questionnaire of over 175 establishments or 70% of the initial sample, preliminary analysis of the returns and subsequent choice of case study firms has now taken place. In the light of this I write once again, for your questionnaire return proved most interesting in the context of the survey as a whole, and I would very much wish, if possible, to use your company as one of my selected case studies.

Meeting such a request would entail an hour or thereabouts of your time (whenever and wherever!) to allow in-depth discussion of certain aspects of your firm. Issues which would be covered during the interview would include, for example:

- The firm's origin and present ownership structure.

- The initial location decision of the firm.

- Certain characteristics of the firm such as its size, products/services and generally "what goes on at the site".

- The form and nature of relationships with suppliers and customers, and other firms generally.

- The existence, nature and form of any relationships with other institutions such as the local council, Chamber of Commerce, higher education establishments, enterprise centres, etc.

- Change in the firm and its external relationships, both past and likely, and the driving forces behind such change.

- The discussion of all the above aspects would take place within the overall context of the firm's location in Hertfordshire and exactly what is to be gained from this location. That is, what is it that Hertfordshire offers or, conversely, what would you most miss if you had to move from Hertfordshire!

I must emphasise that your participation would be most gratefully appreciated as well as, I hope, mutually beneficial in that one of the research's ultimate aims is to identify just what the present relationship between high technology and Hertfordshire is, and to formulate policy suggestions in the light of this.

Finally, I should also reiterate that, just as with the initial questionnaire, any information provided by yourself during the interview will be treated in the **STRICTEST CONFIDENCE** and your anonymity maintained in any subsequent published results. If you have any immediate queries or would like to discuss this matter further *please do not hesitate to contact me* on the above number. Otherwise, I will be in contact shortly to discuss your further participation in the research programme.

Yours sincerely,

Mr. Nicholas Henry BSc(Hons)

FIGURE 7.3: INTERVIEW SCHEDULE

CASE STUDY INTERVIEW SCHEDULE

MAJOR LINKAGES AND LOCATION

Q1. The first set of questions are concerned with gaining information on the firm's origin and its present ownership linkages.

- Who founded the firm, why, and how, did it come into being?

- What is the present ownership structure of the firm?

- Do any other companies own a stake in your company? Who (where), how much and why?
- Did your firm's location play a role in the investment decision of these other companies?

- Does the firm have any financial interests in any other companies? Could you describe these (eg.joint venture?), give the name and location of the company and the reasons behind your company's investment? eg.forward/backward linkages
- IF YES, Did the location of any company invested in play a role in the investment decision?

Q2. A section concerning the location decision of the company.

- Is this site the original location? Where was original location?
- Were any other locations (outside of Herts [SE?]) considered OTHER THAN ...? If yes, where and why? Why not choose them?
If no, why not?

WHY did you locate in ...?

- **PROBE** location factors listed in questionnaire return

Q3. This set of questions deal with the firm's basic characteristics.

- What is your major "product" and hence what industry would you view your firm as engaged in and how would you "describe" that industry if asked to provide an overview of it?
[Get a description of industry? eg. dynamic, large/small dominated, technologically advanced, expanding...]

- Please briefly describe and outline "what you do" in producing your major product.

Q4. The following are questions concerning your supplier relationships.

In your questionnaire return, you gave your two largest suppliers as ...

- How did you "find" these suppliers?

- **Did distance from yourselves have any influence in your decision of choice of suppliers?** If so, what influence and why? [Is their a minimun/maximum distance?]

- What were the selection criteria used in the choice of these supplier/s? eg.cost, quality, responsiveness innovation, reliability, capacity,

- Alternatively, did the location of any particular supplier influence the location of your firm and, if so, in what way and why?

- Are you aware of any of your suppliers having deliberately located close to you?

If we change tack slightly, are satisfactory suppliers easily found within Herts, SE, UK for <u>non-standard, one-off inputs</u>?

In this sense, are (or could) all your needs be met by

local (eg. Hertfordshire) suppliers? Does the area supply a "specialist pool"?

- How would you describe your relationship with your (major) suppliers? ie. long term supplier relationships or does specialist pool allow continual refinement of suppplier base
eg. Possibly need to think through a continuum between commercial (market) and co-operative ...
[subcontractor, special, crucial, important, close, stable, functional, problematic, dominant, have adopted a dual-sourcing policy, two-way etc]

- Reasoning behind relationship outlined...

- Any financial, contractural stakes eg.joint ventures, shares, licensing etc...(already covered earlier?)

- Does the firm have a standard policy towards all suppliers or do relationships vary between suppliers and if so, why and how? That is, what decides the form of relationship with a supplier (the importance of the input/dominance)?

- Does the distance of the supplier from yourselves play any role in the type of relationship the firm has with the supplier?

Q5. This following section is similar to the previous but concerns customers.
In your questionnaire return, you gave your two largest customers as ...

- This suggests that Hertfordshire, itself, does/does not provide a satisfactory market for your products/services (GET % FIGURES FOR SALES IN HERTS?) Could you place geographical boundaries on your "market" OR is the "market" more easily defined in terms of sectors/particular firms?

- Did distance of yourselves from these customers have any influence in the creation of this linkage? If so, what influence and why? [Is their a minimun/maximum

distance?]

- What were the selection criteria used in the choice of yourselves as suppliers? eg.cost, quality, responsiveness innovation, reliability, capacity,

- Did the location of any particular customer influence the location of your firm and, if so, in what way and why?

- Are you aware of any recent geographical shift in terms of the general location of the market, both existing and potential? (ANY SHIFT IN MARKET CHARACTERISTICS GENERALLY)

- How would you describe your relationship with your (major) customers?
eg. Possibly need to think through a continuum between commercial and co-operative...

- Reasoning behind relationship outlined...
 - Any financial, contractural stakes eg.joint ventures, shares, licensing, franchising etc...

- As well as a market for your products are customers used as sources of informational/knowledge input? eg. in the conception of a new product would discussions with customers take place. Or would the initiative for new products possibly come directly from the customers themselves?

- Does the firm have a standard policy towards all customers or do relationships vary between customers and if so, how and why? That is, what decides the form of relationship with a customer (the importance of the input/dominance)?

- Does the distance of the customer from yourselves play any role in the type of relationship the firm has with the customer?

Q6. Has the company undergone any major change in the past three years or so in product, suppliers, customers,

product, production process, internal organisation, etc.

- If so, has this caused any shift, whether positive or negative, in the company's perception of its location ?

Q7. This section is to investigate any other linkages/ forms of cooperation which the firm may have with other (local) firms other than those of ownership and production already investigated.

- Are you involved in any forms of formal or informal co-operation with other (local) firms eg. joint R&D/production, use of buildings, machinery, training, shared facilities, licensing, franchising etc?
- Please describe the nature of these, who they are with and why they have been set-up.
- Do you have any intention to foster/increase any such linkages?

- Do you have any formal or informal links with institutions both public and private eg. council "A1 campaign", chambers of commerce, trade unions, Hertis, enterprise centres, higher education establishments, MSC (now TECS),etc
- Please describe the nature of these, who they are with and why they have been set-up.
- Do you have any intention to foster/increase any such linkages? eg.TECS

- Did the potential for any or all of the above linkages play any influence in the firm's location decision?

- Can you identify any actual/potential linkages which can in some senses be viewed as unique to Hertfordshire?

Q8. This section aims to find out the nature of the relationship between the firm and its present location in Hertfordshire.

- What do you view as the advantages available from your firm's present location in Hertfordshire (SE)? What does

the location offer to the firm?

- PROMPT NOTION OF "INDUSTRY IN THE AIR"

- What do you view as the disadvantages of your location?

- Does the present location have any advantages/disadvantages in terms of distance from suppliers?
- Does the present location have any advantages/disadvantages in terms of distance from customers?

- Have you ever considered, or are you likely to consider, relocation outside of the region? If so where and why? If not, why not? **What would you most miss if you had to move from Hertfordshire?**

Q9. Finally:
- How do you view the firms' future? What do you see as possible "potentials"? What do you view as "essential" to its future? Similarly, can you highlight any constraints to the firms' future well-being?

CHAPTER EIGHT: Further Explanations For "High Technology Hertfordshire": The Remaining Majority and Their Locational Process

8.1 Introduction

So far, our explanation of the growth dynamics of high technology Hertfordshire, based as it is upon the transaction costs mechanism, is far from complete. For it has dealt with less than a quarter of the high technology establishments surveyed. So what of the other three-quarters of the sample? If major production linkages were not important to their location why was this so and, therefore, what was important to this group's location in Hertfordshire?

Firstly, it could be that "major" production linkages were not "critical in location" but other local linkages were. In other words, the criticism raised in Chapter Seven that the survey may have been looking at the wrong linkages could be correct. Although Chapter Seven revealed that certain major linkages **were** critical in location for a particular set of establishments (ie. the group of "31+4"), maybe the bulk of such "critical" production linkages were not of this kind. For example, 40 (32%) of the 126 establishments in the remaining (majority) group did actually have a major production linkage within Hertfordshire but none were viewed as critical in their location. Possibly, the production linkages which were "critical in location" were not "major" but other types of

local linkage and, hence, their non-identification meant the operation of the mechanism in these cases was totally overlooked.[92]

Alternatively, maybe the transaction costs **of any kind** of production linkage simply were not a factor in the location of these establishments; the mechanism was not operational. Or, finally, the possibility exists that the transaction costs mechanism may have been operating but was simply subsumed within other dynamics of location which ultimately determined the locational outcome. As already suggested, the same outcome may be created by different (or combined) causal processes. An outcome which fits the New Industrial Spaces model may be caused by a process different from that hypothesised. So, did this remaining group represent an only partially-successful research design, evidence of a locational mechanism of little actual empirical relevance or a combination of the two?

The way ahead to the answer lay within Question 6 of the questionnaire. It may be recalled that this simply asked for the most important location factors of the establishment. No location factors were prompted except, sub-consciously(?), the role of major production linkages which had already been investigated in the preceding questions. Establishments responded in a "prompt-free environment" listing those factors which they saw fit. **Inclusive of this was the ability to identify other production linkages if they were relevant, whether**

[92] Whether this is the case or not, this group of 40 firms also highlight the dangers, once again, of prioritising linkages purely because of their being local (or big) in nature.

major or minor. In fact, it has already been seen in Chapter Seven that in the cases of **KV** and **ALA** the respondents did just that, referring to "local suppliers" as location factors. Thus, Table 8.1 lists those location factors identified by high technology establishments in Hertfordshire (excluding the group of "31+4").

TABLE 8.1 The location factors of high technology establishments in Hertfordshire

Location factor		No.of times listed
Residential location		55
Communications		37
- Road	20	
- Air	9	
- Rail	6	
- Ports	1	
- Not specified	1	
Proximity to London		18
Labour		20
Property		10
Local suppliers/customers		7
Spatial policy eg. New Towns, IDCs,		5
Spin-off from local parent		5
Acquisition		4
Take over premises of "sister" company		4
Environment		4
"Inertia"		2
Unclassifiable		7
No reason given		8
Total		**186**

Sample number = 126 establishments

So what interpretation may be made of this list of location factors?

8.2 Other Processes of Location

Residential Location

Firstly, residential location was the most important location factor for this group of establishments, representing 30% of the total number of location factors identified by individual establishments. Moreover, in 43 cases (34% of the group) this was the only location factor listed. This finding proved similar to that of Breheny and McQuaid (1988) for their study of high technology industry in Berkshire (also, concerning Cambridgeshire, see Keeble,1987; 1988; 1989; Keeble and Gould,1986):

> "When considering why firms have located in Berkshire, it is useful to distinguish new single plant establishments from branches of foreign or U.K. firms. Twenty-four of the firms interviewed fell into the first category. The reason for the initial location of the new firm in 21 cases was simply that it was within commuting distance of where the founder lived when he (unfortunately, all he's) finished his previous employment. Hence, if one wants to understand why a new firm starts in a general location (as opposed to a specific site) then residence is important." (Breheny and McQuaid,1988,p.332)

But Breheny and McQuaid (1988) did not consider residential location as a location factor for branches. In contrast, this study found that residential location was also

important in the location of several branches, operating through several avenues and highlighting the danger of reductionism inherent in the term "branch".[93]

Firstly, where a branch was created through "virgin development", the residential location of the UK director or a key employee could still determine the location of the branch. Such was the case, for example, with Eberle GMBH's branch set up in 1972 and Nantucket UK Limited, a Los Angeles based multinational which opened a branch in Hertfordshire in 1986 (postal questionnaire returns). Secondly, a "branch" may be created through acquisition. Whilst the location of the acquisition may or may not play a role in the investment decision (see case study **PB** later), several respondents of such branches still identified the residential location of the original founders as the key location factor. The firm, **DIL**, identified within the previous set of outcomes was one such example, as was Cybermation, a company founded by ex-members of Hatfield Polytechnic, which has subsequently become a branch of the US company Dynatech Corporation (postal questionnaire return).

In the context of the New Industrial Spaces thesis, however, residential location may be a critical location factor because it predominantly signifies a process of new firm (as against establishment) formation. It is precisely this dynamic of disintegration (where it leads to the extension of the social division of labour) which the New

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[93] The term, used to describe an outcome, unless interpreted carefully may lead to the conflation of a variety of different casual processes which may create a "branch".

Industrial Spaces thesis argues drives the process of agglomeration. So, if, as earlier in the case of KA, it is the knowledge of local linkages and the phenomenon of "high technology industry in the air" which is the dynamic to the foundation and location of these firms, the transaction costs mechanism may well be applicable in such cases.

Thus, just as in Chapter Seven, further case studies were undertaken to investigate the location mechanism. Establishments VA and PB, both of whom stated that their only location factor was residential location, were chosen. A further interesting aspect of these establishments, however, was that they also had "major" production linkages within Hertfordshire but had not said that these linkages were important in their location. Indeed, in the case of VA, it was only one of two companies which had three of its four (asked for) major production linkages internal to Hertfordshire.

VA

This computer services firm, employing 8, was set up in 1987 by an ex-employee of the technical publications department of BAe, Stevenage. Its initial aim was "to sell computer hardware and software to local industries" concentrating, in particular, on after-sales service and support. Its major product is accountancy software packages, enhanced to fit the particular needs of the client, but VA has also expanded into typesetting, graphics and technical publications for local business (including aerospace). Both of the company's major

customers were located within Hertfordshire and this was explained by the company's target market which was stated as local industry within a 30 mile radius of its location. **VA**'s major suppliers were a local printers (run by old friends who had started the business at a similar time to **VA**) and a supplier, based in Newcastle, who provided the standard accountancy software package to then be "enhanced" for clients. Further investigation of **VA**'s supplier and customer linkages revealed that the company was, in fact, part of a local production network:

> **"We've got somebody who does all our print for us. Likewise, if we have any requirements that they want we will do it for them. There is another company locally that [we use] if we have a major installation and we can't fulfill all of the parts of the installation process ourselves (ie. we haven't got the manpower available at the time to do the cabling). And likewise they often buy our services back off of us. So, thinking about it, yes, if I were to look at my customer list against my supplier list there are a fair few that we work both ways on. We work for them, they work for us....You know we could get an order in today and be able to cope with that installation quite easily. Get another one in tomorrow and the customer wants it done at the same time as the first one [but] you can only cope with so much at one time. We could pick up the phone and they could come to our help immediately which is good. They are all local."**

Furthermore, such local production had also involved the company in a joint venture with a software house in Stevenage which it had met through the council-run "computer users club". However, discussion of the greater

concept of "high technology industry in the air" met with the response:

> "I don't think it would really affect us because we have such a wide [but local!] span of client. It can be anything from a hairdresser down the road up to a steel company."
>
> "The type of system we're prepared to put in and support...any particular industry wouldn't really matter to us." (personal interview)

And this provides a critical insight into the nature of this disintegration dynamic. For whilst the company is itself "high technology" and its suppliers and market are "localised", the suppliers and market themselves are predominantly **not** high technology. The company was set up due to the potential for local production linkages with local industry and not with local high technology industry *per se*. Whilst there is evidence for the transaction costs mechanism, it is again part of a **derived dynamic. VA** is a product of the structural change in the use of IT in all production processes in industry (eg.accountancy and publishing) rather than a geographically bounded extension of the social division of labour within high technology industry. Thus, when asked what would be most missed if the company was forced to leave Hertfordshire, the interviewee replied customer contact yet, at the same time, it was pointed out that the company could survive wherever there was a concentration of industry, whether or not that industry was high technology.

PB

In contrast, **PB**, founded in 1979 by two local inhabitants, did aim to supply hardware and software to the large numbers of pharmaceutical (ie. high technology) companies in the county. In 1981/2, the company was taken over by another local person (the interviewee) who was fed up with commuting. Thus, whilst the company was a good proposition, the fact that it was close to the new owner's home did play a role in the acquisition.

PB's major supplier is Apple Macintosh based in Uxbridge. In fact, its only major supplier is Apple because it is an "Apple Centre" and thus only allowed to sell Apple products. Hence, **PB** further exemplifies how the power aspect within relationships can mediate the possibilities for companies to set up local linkages. In fact, **PB** has permission to buy and sell "Apple compatible" products and these products represent their other major form of supply. However, in a logic exactly opposite to that proposed by the transaction costs mechanism, the role of distance within **PB**'s supplier relationships is deliberately downgraded.

For example, the company had recently undertaken a rationalisation of its suppliers. At the meeting to decide which suppliers to keep or drop, it had been argued that one particular supplier was "down the road" and advantages could be gained from this. However, the location of the supplier was subsequently deliberately excluded from the

calculation. For it was argued that PB held no sway over this supplier's location and thus this factor should play no part in its choice as a supplier! A deliberate policy against the mechanism's logic was held by the company.

In contrast, distance played a critical role in the company's customer relationships:

> "We can't move out of Hertfordshire."
> "We have so many customers around here we couldn't be somewhere else".
> "The problem is that our customer base is now here. So it's not a question of advantages [of Hertfordshire], it's a question of fact of life now. We couldn't service this customer base in the way we do without being in Hertfordshire. We're basically stuck in Hertfordshire with the problems Hertfordshire's got as well".
> (personal interview)

However, customers were again not chosen on the basis of their being high technology. The first market segment was "corporate" and Hertfordshire was critical due to the large numbers of, in particular HQs of, "top" companies in the county. Moreover, again highlighting the role of power in relationships, HQs were targetted due to the access they subsequently supplied to branches. The second market segment was education, in which a presence in the Home Counties and London was important but not essential. Finally, the third and fourth markets (and predominantly local) were the publishing industry and small and medium-sized establishments (SMEs) generally.

"Local presence" was critical for PB because it provides a major after-sales service, including maintenance, along with its computer systems. Such maintenance contracts include, as standard, an 8 hour "repair or replace" clause but the company was increasingly moving towards the provision of a 2 hour response. To provide such a response requires proximity, although for clients in Northamptonshire, for example, this presence was maintained by an "engineer on the road". So a "distance" mechanism was tying this high technology company to Hertfordshire, but through its customer (not supplier) relationships and, through customers gained by targetting an only coincidentally high technology market. Thus, on discussion of the concept of "high technology industry being in Hertfordshire's air" the respondent argued:

> "As to whether or not it's true, yes, it has got an element of truth. As to whether or not it's relevant, no. As far as we're concerned it's totally irrelevant."

Hence, in the cases of both VA and PB, whilst they were high technology and engaged in some form of local production, "high technology Hertfordshire" was viewed as an irrelevance.

Local suppliers/customers

If the transaction costs mechanism had been overlooked within this remaining majority group (due to a concentration on major production linkages), it could have been expected that "local suppliers and customers" would

have figured more prominently as a location factor. In fact, of the seven establishments mentioning this location factor (see Table 8.1), only one, **GS**, specifically identified "many computer/electronics companies and subcontractors" and was chosen as a case study for this reason. Another respondent did identify "links with local industry" but not "high technology industry" per se.

The ownership and control properties of linkages, and their role in location, were further highlighted by two branches in this group of seven. For both these establishments were located in Hertfordshire as part of overall company policy to provide better geographical coverage for the service they offered. Whilst it can thus be argued that such policies inherently include a concept of "local presence", again this production linkage dynamic is far removed from integration into specialist supplier networks as implied within the New Industrial Spaces mechanism.

In contrast, whether any notion of the "local" played any particular role in the location factors of "acquisition" and "take-over of sister company sites" is difficult to decide. Such sites, in certain instances, did have local linkages but these examples merely serve to reinforce the problems and dangers of prioritising linkages in location because they are local, and viewing branches and their locational decisions as equal to those of independents. For example, the original location decision of such sites was often lost in time, but the history of the particular function being at that site could be traced through any number of a series of company restructuring processes such

as take-overs, disposals, rationalisations and expansions, etc,[94]. Exactly what role, if any, geographical location played in these decisions is unknown and hence any intepretation of such establishments as "geographical outcomes" must be extremely tentative.

GS

If we turn to the case study GS, employing 25 people, its two location factors were "desirable place to live" and "many computer/electronic companies and subcontractors". Again, the founder had worked for a major local electronics company, but had become disillusioned with a lack of commitment to R&D, and so set up his own company, based on bar-coding technology, in 1972. GS's major suppliers were local and the ease of communications was seen as a "genuine off-set against production costs", although suppliers had to be very close. But a supplier base did not exist for all aspects of the production process so, for example, a "critical" and highly specialised input was gained through a link with Edinburgh and Dundee Universities (after several years search). In this case, it had not been a question of where the supplier was but where you could get the supply.

The customer base for GS was diverse and little to do with Hertfordshire. Interestingly, however, the respondent recounted a story of a local customer which was a branch. A hardware deal had been signed but the branch's HQ had tried

[94] See Massey and Meegan (1982) for examples of the geographical outcomes of some such processes and Fothergill and Guy (1991) for explanations of the possible role of geography in such decision-making processes.

to overturn it on discovering its existence. In other words, the branch lacked autonomy to create "local linkages". It was not an "independent" entity.

Again, however, and despite involvement in local supplier linkages, the suggestion of a local high technology industrial network was dismissed. The respondent argued that no communication between local high technology industry occurred because no effective mechanism, formal or informal, existed for such communication. Indeed, the location of the firm in Hertfordshire was increasingly viewed negatively due to "appalling roads", high house prices, labour shortages and lack of support from local bodies. Recently received literature from Sophia-Antipolis had merely confirmed the respondent's negative opinion towards the amount of support given to high technology both within the county and nationally.

Labour

A further location factor which may provide possible evidence for the claims of the New Industrial Space theorists is that of labour. For the argument is that within the New Industrial Spaces pools of labour with particular and deep-rooted skills are likely to be created as part of the agglomeration dynamic (see Chapter Four). In fact, some of the earlier case studies in Chapter Seven provided evidence for such labour markets and the intricate and flexible forms they may take. However, it must be added that, in certain instances, the case studies also revealed how the particular need for skilled labour (or indeed

labour *per se*) has acted to override the operation of the transaction costs mechanism. To investigate further the existence and role of local labour markets in the New Industrial Spaces the company MB was chosen as a case study of those establishments citing "labour" as a location factor. For, firstly, MB identified the critical supply of skilled labour to the point of naming a particular place within the county, Barnet[95], and secondly, it listed "inertia" as a location factor.

MB

MB, engaged in the optical precision instruments industry, employs 11 people. Despite its small size its turnover broke the £1 million mark in 1989 and this had already been surpassed as the company entered the fourth quarter of 1990. It has agents in every continent and virtually every country in Western Europe. In 1989, about half of its turnover was from overseas customers which (including agents) numbered 76. After graduating in physics some years ago, MB's founder moved to the area to work for a major optical company (W). By his mid-20s he had set up his own optical company (D) but, after a dispute with his backers, he left to become a technical director of another local optical company. D is now a major competitor of MB, itself set up in 1983, and started from the founder's bedroom where he designed and sold optical components (now also sub-systems), which a skilled optical worker produced in

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95 Strictly speaking Barnet and East Barnet are outside Hertfordshire (but right on its borders). However, they were part of Hertfordshire until 1965 when, in a re-drawing of local government boundaries they were "exchanged" for Potters Bar, the location of this case study.

the garden shed.

The interviewee described how in this part of Hertfordshire and North London there is more than a 100 years tradition of optical manufacturing. Moreover, optical manufacturing is an industry whose basic production process is, so far, resistant to automation:

> "Optics is one of the few manufacturing methods left which uses a genuine hand skill."
> "So what happens is that companies that wish to work in this field, if they want skilled workers, tend to have to locate here. Because you'll quite often find that they [the skilled workers] will not move...And that is what [is] meant by 'inertia'. [The founder] was living here at the time and also there is a pool of skilled optical workers."

As the interview continued it became clear that this specialist local labour market was one element of an optical precision instruments **"industrial district"**, complete with specialist suppliers and production practices based on mutual co-operation.

> "Most of what we require we buy within Hertfordshire as far as we can. Raw materials, tools, measuring instruments, devices, electrical goods, heating instruments."
> "It's certainly true around about this part of Hertfordshire [that] there are numerous optical companies...[and] there are numerous suppliers of optical materials."
> "Well, it's an advantage. But, one of the more important advantages is the fact that it's a relatively small and specialist

industry and we know everybody... They're in effect friends. It's certainly convenient to have them close at hand... for example, things like transferring materials. It sometimes happens we need an operation carried out that we can't do in our own factory. We actually take work to somebody else's factory and pay them to do the work for us, because we're doing similar kinds of trade. That kind of thing is a big advantage. There's a company down in Barnet who specialise in glass, we specialise in infra-red materials. Quite often they will accept an order for infra-red materials but we will make it. And vice-versa, we will get an order for glass components, we will subcontract it to them. So that is very good. I mean its the kind of thing you would hesitate to do if they were 200/300 miles away. A lot of these things can literally be transferred within the county, within thirty minutes almost in any direction."

But how do you know you are getting a good price?

"We expect to get good prices from our colleagues in this business. But quite often the price doesn't enter into it. We don't sort of go out to competitive tender before we transfer a job to another shop. It's done and we pay for it. Because we know how much it costs, they know how much they can charge. It's done really because of proximity and personal contact."

This style of business relationship was symptomatic of the cooperation which goes on within the industry:

"We use each others' facilities. [The founder] is a top flight optical designer and you will find that other subcontractors will make an inquiry which doesn't define the component adequately,

physically. Somebody wants a lens which will do this, a mirror which will do that. And they will phone up and say to [the founder], 'what do you think?' and he will tell them. So there's that kind of cooperation goes on. We share, if we have to, manufacturing processes. There have been occasions where we've shared material as somebody needed material quickly and we had stock and he wanted it before his normal supply was delivered, we'd do that. We share tooling. Optical manufacturing involves buying very high precision radius tooling. We share those. We find that we might need a tool so we'll ask a company if we can borrow it."

"There was an optical company started up, I don't know why, over 100 years ago. But it has produced offspring which are numerous small companies... None of the companies in our particular business are particularly large. Thirty people is quite a large number to employ in this kind of business. Most companies are relatively small. Because of the optical skills involved it's possible for a man [sic], in effect, to work for himself and make a good living. That's because he's selling a skill other people can't replicate. So, it's certainly true I think that that has happened, there's a kind of cohesive action has happened. In this industry we share employment, we share the market, we share skills, we share manufacturing."

Thus, a description of an "industrial district" was supplied by the interviewee, a district which the company would be loathe (unable?) to leave:

> "It would be very difficult to take our skilled workers with us. That's almost it stop... The big problem would be personnel. Apart from that there isn't actually anything really. There is nothing

insurmountable. We would move and we would get by. The fact that we would be remote from suppliers doesn't matter, the fact that we might lose out on the facility that we had with fellow manufacturers, we could get around that. It wouldn't stop us. But the biggest handicap would be literally trying to move the skilled employees, trying to take them with us."

So you could break from the production network?

"We would if we had to. But I mean it's not something we would like to do... [although the respondent gave evidence of people who had.] The greatest impediment would be problems of moving skilled workers. If they wouldn't go we couldn't get round it. We would lose the interplay with other fellow manufacturers but we could live. It would be difficult, but it wouldn't be impossible."

Several further points were raised by this case study. Firstly, their major suppliers were STC Components in Essex and a company in Oxfordshire. Their major suppliers were also highly specialist:

"One of the materials we use to manufacture is Zinc Solenoid(?) which is only manufactured in adequate quantity and quality in the United States. Z represents one of the [US] manufacturers. We need to buy that material, we buy from both [UK] suppliers. A supplier...up in Coventry and Z in Oxford. It also has happened, and this is where you find it's such a small pool, the guy who runs Z used to work for W and he also used to work for D. When [the founder of MB previously] started D, this guy worked for him so they knew each other."

In the case of STC Components, MB deals with an internal department which began taking subcontract work. But:

> "The reason that we used them was because they were there. They were the only UK source of the kind of coatings we were using. Since then there are other companies..."

Thus, it needs to be stressed, that in the case of the most "critical in production" linkages, distance played no role. As the interviewee stated, **MB had no choice as to where to source these supplies from.**

Secondly, there was the continued reference by the interviewee to the small pool of key people in the industry. Thus, a major supplier and many other suppliers were personal friends previously worked with. Moreover, the two major customers (including one from France) were also personal acquaintances from previous companies. It was not a question of labour turnover but labour rotation, a game of "industrial chairs" as the interviewee put it. However, the pool of such skilled people and labour was getting smaller and older. Thus operators were being paid high wages with additional perks of company cars and pension funds. Critically, this situation was unlikely to change in the forseeable future. Whilst MB took on apprentices (despite its size) it stood out in the industry in doing so. Otherwise, the interviewee was unaware of any technical college or vocational scheme aimed at training optical workers.

"Inertia"

The above case study highlighted a particular view of inertia, a view which supported the New Industrial Spaces thesis. For it was a view of "inertia" whereby a company felt unable to relocate away from the (unique) advantages of the production network within which it was situated. Thus, the final case study was **PK**, a company located in the county in 1948 which stated that its location factors were "no longer relevant after 40 years! We stay because we are here, we may have to move, if we expand, to a cheaper area". The question to ask was whether or not forty years of location within the region meant their staying put, not because they were here, but because of an array of advantages gained from "immersion" over time within a local production agglomeration.

PK

The company employs 80 people and principally designs, develops and produces high technology products for the automotive industry. It is at present a supplier of Ford. It also does subcontract work to keep it "ticking along" with local customers including Rank Xerox, Bull and BAe. However, an interesting story lay behind the BAe work. For the company is literally surrounded by BAe (it is next door on three sides!) but BAe was unaware of its ability. Thus, when BAe required a "giro bit" it looked abroad and nationally. Subsequently, after the failure of this search, the presence of **PK** was brought to their attention and **PK** was able to meet their requirements. After several decades

of location next door to each other BAe was still unaware of what PK could offer. **Spatial contiguity does not generate synergy as a matter of course** (see Gordon quoted in Chapter Four).

PK did suggest that there is a "self-contained industrial community" but this was for basic "metal-bashing" which was **not high technology** and was argued to be available wherever a major manufacturing presence exists. Moreover, the company was not worried where its suppliers were and, indeed, due to a knowledge of Scotland had recently looked to source some of its supplies from there. Thus, when asked what would be most missed if PK was forced to move from Hertfordshire (and it was not averse to doing so if labour supply got worse) the interviewee replied:

> "We know it and know its capabilities. Even if we're not dealing with them now, you name a supplier and we probably have dealt with them. We're pretty familiar with their strengths and weaknesses. There are some local suppliers you wouldn't touch with a barge pole. If you go to a new place you don't know who they [the bad suppliers] are yet!...Familiarity, I suppose, that's really what it comes down to."

Thus, whilst this could be viewed as an agglomeration advantage, it was hardly the dynamic inspired by notions of the New Industrial Spaces.

8.3 Concluding Remarks

Thus, unsatisfied with the mere knowledge of its existence,

Chapters Seven and Eight have outlined a detailed investigation of Hertfordshire as a high technology agglomeration. Its cohesiveness as a production complex (rather than just a grouping of high technology firms) has been investigated, along with the locational imperatives which may arise from such an agglomeration and, in particular, those imperatives determined by production linkages.

The reality revealed is of a production complex of great complexity; in effect, a variety of production complexes. Moreover, each complex represents a group of firms connected by their own location logic (often?) based on a particular production linkage process. In only some (the minority of) cases was this process found to coincide with the transaction costs mechanism of the New Industrial Spaces theorists. What these results reveal about the dynamics of growth within Hertfordshire but, also, the alleged dynamics of other contemporary agglomerations of production will be discussed in the final chapter. It is in the final chapter that concluding remarks on this thesis's investigation of the New Industrial Spaces theory will be made and the lessons drawn for our continued attempts to understand the geography of production.

CHAPTER NINE: Variety Is The Spice Of (Productive) Life

9.1 The Process and Pattern of Interest

It has been clear from the beginning of this research thesis that whilst much of its content is based on the description of patterns - aggregate numbers employed, the geography of employment, the geography of production linkages, the characteristics of Hertfordshire industrial establishments and so on - its explicit focus has been to seek to explain these patterns. In other words, to reveal the causal processes operating to create these patterns. Moreover, the exact form and status of "processes" and "patterns", and the relationships between them, has been continuously touched upon.

The pattern of central interest to this research has been the apparent emergence of a new form of uneven spatial development within Britain. Whilst numerous components constitutive of this pattern may be observed, such as the (spatial) restructuring of established industry, possibly the most symbolic component is that attributable to the new industries which have come into being in recent times. Of utmost prominence amongst these new industries are those referred to as "high technology". Hence, the pattern upon which this study has focussed has been that of the uneven spatial development of high technology industry in Britain and, in turn, the study's central aim has been that of illuminating our knowledge of at least some of the

processes actively constructing this uneven geography. Moreover, this research aim has been followed in the context that such knowledge is of a greater significance. For it is argued that the rise of high technology industry is indicative of a new phase in the historical (and spatial) development of capitalism (Scott and Storper,1986; Scott,1988a; 1988b). Thus, to understand the forces driving the uneven spatial development of high technology is also to understand those forces shaping the emergent (uneven) geography of production as a whole.

But, from the start, such an aim has been hampered. For a pattern based on "high technology" may, itself, be a pattern representing a "chaotic conception". It may signify a pattern which, in reality, "lumps together the unrelated" (Sayer,1984,p.127), a pattern which confuses rather than illuminates processes and/or, at its most extreme, a pattern underlain by no common process whatsoever. Thus, this thesis has discussed the use of theories of structural change as an attempt to overcome this problem of definition (cf. Chapter Two).

The appearance of certain technologies, and their associated industries, may be conceptualised as a key element of a greater **process** of structural economic change. Subsequently, it is the structural role ascribed to different kinds of technology representing **processes of change** which acts as the overriding definitional criterion of particular groups of technologies and the framework within which may be devised a series of "indicators". In turn, a group of technologies, connected first and foremost

by their common inclusion as part of a particular form of change, may be labelled "high technology" if so desired. Thus, for the New Industrial Spaces theorists (and therefore this investigation of the theory), the form of structural economic change is the transition to flexible production and accumulation; the "technology of flexibility" corresponds with "high technology" and the producers of such technology represent one of several "flexible industrial ensembles", carriers of the new systems (both technical and social) of flexible production (cf. Chapter Three).

Furthermore, such flexible industrial ensembles are also "spatial" and, moreover, they tend to a particular spatial form. These ensembles present more than a new production logic, they also present a "territorial logic". And, within the theory of the New Industrial Spaces, the argument is that the particular spatial form (logic) of the flexible industrial ensembles is that of "(re)agglomeration". It is this argument which has been investigated within this research. Or rather it is the argument as to **why** this should be which has been particularly scrutinised. Why is it that (high technology) flexible industrial ensembles should tend towards agglomeration (thus forming the New Industrial Spaces)?

9.2 Explaining the Pattern

The investigation of this argument has involved two elements. Firstly, the theoretical explanation put forward within the New Industrial Spaces thesis has been analysed

for its "logic". That is, does the theory provide a structured, step-by-step explanation of a possible process of location. Secondly, whilst such an explanation may be "theoretically logical" the question to ask then is whether or not it is also "empirically logical". In other words, is it a logic which firms actually subscribe to in their locational decision-making. The investigation of empirical logicality has involved a study of firms located in "high technology Hertfordshire".

Investigating the theoretical explanation first, the answer for the theorists of the New Industrial Spaces has been seen to lie with the "transaction costs mechanism" of location which, with the historical shift to flexible production, is engendering a tendency to agglomeration. In a detailed analysis of this explanatory mechanism, the present research thesis has drawn a principal distinction between that of a theoretically possible "logic of location", traceable through a distinct set of steps, in contrast to a theoretical "logic of necessity" as implied within the New Industrial Spaces theory. Thus, for example, it was concluded that it is theoretically possible that, once triggered, the transaction costs mechanism can cause agglomeration. But, in a further expansion, it was also concluded that the mechanism could operate but be overridden, thus agglomeration need not necessarily result, and that the outcome of agglomeration may similarly be caused by mechanisms other than that of transaction costs.

The consequence of these conclusions was that a turn to the empirical evidence, as put forward by Scott, of

agglomeration caused by the transaction costs mechanism proved inconclusive. For whilst evidence of agglomeration, a possible outcome of the mechanism (but also of other mechanisms), was clear to see, evidence for the transaction costs mechanism operating to cause such agglomeration was not. Concomitantly, as the critical defining criterion of the New Industrial Spaces, the lack of evidence for the mechanism thus implied a lack of conclusive empirical evidence for the New Industrial Spaces themselves. Thus, from Chapter Four it was concluded that whilst the New Industrial Spaces thesis (with certain refinements and provisos) did put forward a theoretically logical explanation of agglomeration it had not, as yet, proved it to be an empirically logical explanation.

9.3 The Search for Empirical Validity

Thus, the remainder of the research thesis is the story of the search for that empirical evidence (logicality) and hence, confirmation of the validity of the theory of the New Industrial Spaces. It is the story of a search structured by the knowledge that the identification of a "pattern of agglomeration" is not enough, it is merely the first step. Indeed, the story becomes a depiction of the step-by-step dissection of a pattern of agglomeration known as "high technology Hertfordshire".

Outwardly, high technology Hertfordshire exhibits some of the characteristics attributed to the New Industrial Spaces. Hertfordshire represents a major contemporary agglomeration of high technology industry (cf. Chapter

Six). But, at this point, the term "agglomeration" is used in the loosest of forms. It represents merely a group of spatially clustered firms engaged in producing products viewed as "high technology". If the New Industrial Spaces thesis is truly to hold any analytical (as against descriptive) significance, a much tighter definition of "agglomeration" must be taken. And, indeed, such a definition may be taken. For the attractiveness of the New Industrial Spaces thesis is that the definition of agglomeration is not simplistic nor ahistoric nor arbitrary. Rather (the definition of) agglomeration is a logical extrapolation, structured as it is by the characteristics of the historical shift in the organisation of production of which it is the geographical expression. Hence, the definition of a New Industrial Space (agglomeration) may be seen to hold at least four key elements:

1) The New Industrial Spaces are agglomerations of a particular historical period. They are part of the post-Fordist era of flexible production.

2) Relatedly, they are agglomerations of leading industry of this (flexible) era. In other words, agglomerations of the flexible industrial ensembles.[96] Thus, first and foremost, it is not a case of whether or not electronics,

[96] This thesis has only dealt with the New Industrial Spaces created by the flexible industrial ensembles. However, it must be remembered that Scott and Storper argue that a second group of New Industrial Spaces are being created by restructuring Fordist industries (see Chapter Four), although these authors too have predominantly concentrated on the former group of New Industrial Spaces.

ceramics or pension funds are sold by particular industries but rather the fact that these industries are the flag-bearers of flexible production systems.

3) Integral in the production logic of the flexible industrial ensembles, is that these ensembles also maintain "localised production networks". Production linkage agglomeration, over and above (and indeed only possible with) locational agglomeration, is an essential part of the production strategy.

4) This is so due to the economies to be gained from such agglomeration, principally those achieved through shortening "critical" production linkages (although local labour markets are increasingly being emphasised, see Scott 1991). The transaction costs mechanism is the principal dynamic of the agglomeration.

So, if we are to identify a New Industrial Space (agglomeration) as against any agglomeration, the criteria above must be met. Unfortunately, the previous pages of this thesis have highlighted how Scott has thus far failed to meet these criteria when identifying the New Industrial Spaces. Theoretically, the New Industrial Spaces are a clearly defined set of production agglomerations. Such definitional clarity has not, however, been carried through in the empirical search for, and identification of, the New Industrial Spaces.

The New Industrial Spaces: Agglomerations of the post-Fordist flexible era

The most sceptical of critics of the New Industrial Spaces thesis argue that not even the first criterion may have been met (Amin and Robins,1989; Lovering,1990). Amin and Robins (1989), unconvinced by the empirical evidence for the transition to a flexible era itself, are highly sceptical that the variety of production complexes across Western Europe and North America thus far identified as New Industrial Spaces can be grouped under the same rubric. In essence, they question the empirical (and theoretical) difference between the "old" and the "new".

The New Industrial Spaces: Agglomerations of the flexible industrial ensembles

Following this study's investigation of high technology Hertfordshire, doubt as to the coherent **empirical** application of the second criterion may also be raised. Those industries prioritised within the New Industrial Spaces thesis are **theoretically** defined through the combination of two principles. First, and foremost, is the fact that they are flexible industrial ensembles. That is, they are industries based on, and symbolic of, the emergent era's organisational principle of flexible production. Subsequently, flexible industrial ensembles may also be sub-divided into industry groups on the basis that various sectors may be identified which produce similar products, for example, "business services" or "high technology". Concentrating on high technology, this implies that within

the New Industrial Spaces thesis all "high technology" products are produced, by definition, within flexible production systems. The New Industrial Spaces thesis conceptualises the appearance of "high technology" with that of the new era of flexible production. High technology is flexible industrial ensemble is flag-bearer of flexible production and accumulation. Thus, the fact of "high technology" growth (within the suburban technopoles and isolated urban sites of the "sunbelt" areas of North America and Western Europe) is viewed as the fact of the New Industrial Spaces (Scott,1988a).

High technology and flexible?

When moving to the empirical realm the ordering of the principles used in the theoretical definition of "high technology" within the New Industrial Spaces thesis has, however, become blurred and even reversed. Chapter Two revealed how most definitions of high technology are (as are official industrial statistics), in actual fact, based on the (New Industrial Spaces sub-) principle of product created and not method of production. Chapter Three revealed therefore that most empirical work on the geography of high technology is also, unsurprisingly, based on identifying industries by product created. The point is, however, that any agglomerations apparent within these particular geographies of high technology cannot be immediately equated with the New Industrial Spaces. To do so would see the sub-principle of "definition by product" overriding the critical definitional principle of (flexible) "form of production organisation" and, thus, the

critical equation of "high technology" industry equals an era of flexible production may be broken.

If such "geographies of high technology" are to be equated with the New Industrial Spaces then further empirical study of any "high technology" agglomeration must be undertaken to discover the methods of production organisation employed within them (ie. whether they are flexible or not). Whilst such a requirement may be particularly taxing due to the method of compilation of official statistics, it is critical if the theoretical rigour of the New Industrial Spaces thesis is to be maintained. However, in many cases, the empirical evidence of a variety of "sunbelt" areas so far identified as New Industrial Spaces, fails to apply this important theoretical distinction.

Indeed, this point was brought to the fore by this research's investigation of high technology Hertfordshire, part of an English sunbelt which has been labelled as a New Industrial Space. For the investigation of the region initially followed the method, and (empirical) definition of "high technology" (see Chapter 5), used by Scott and Storper and thus, by default, included the accompanying assumption that such high technology industry is also a "flexible production system". No investigation of whether or not Hertfordshire's high technology industry is a "flexible production system" was undertaken but the wide sweep of such an assumption was highlighted by the fact that, in Hertfordshire, such a definition of "high technology" encompassed establishments employing one person to several thousand, in industries ranging from printed

circuit boards to aerospace to computer services, and establishments which were set up over a 60 year period.

High technology, flexible and post-Fordist?

So, a first issue to raise is the ordering of the principles used to define flexible industrial ensembles. In contrast with many attempts at definition (particularly of high technology), it is the process of production (theoretically if not always empirically) that is prioritised over product created within the New Industrial Spaces thesis. A second problematic issue made clear through the empirical investigation of Hertfordshire is, however, that these principles of definition are not, in reality, exclusive to a particular historical (post-Fordist) period of industrial production. For a "high technology flexible industrial ensemble/district" was discovered in Hertfordshire which is not a recent phenomenon, namely the optical precision instruments industry. This industry had been present in the area for approximately 100 years! Whilst it may be part of a contemporary industrial agglomeration, its growth is not due to the transition to post-Fordism. It is a "high technology flexible industrial ensemble" of a different era. Or rather, is it that optical precision instruments has only become labelled and recognised as "high-technology" in the present era? For in previous eras, such as Fordism, "high technology" implied car production or petrochemicals.

Now, within the debate about the move to post-Fordism, especially between Gertler (1989;1990) and Schoenberger (1990), we saw how a (post-Fordist) flexible production system could exist (but not dominate) within a period of Fordist production, and the optical instruments industry of Hertfordshire would seem to substantiate this claim. The problem is, however, the implication that industrial agglomeration in Hertfordshire, because it is high technology, is new and thus a New Industrial Space. The fact that the optical instruments industry is called "high technology" is new; the fact of its existence is not. In contrast, the growth of another high technology flexible industrial ensemble in Hertfordshire, namely computer services, may be seen as new. Moreover, this growth may then also be viewed as part of a post-Fordist dynamic of agglomeration. However, the point to make is that any reading of the (complete) pattern of high technology industry in Hertfordshire as representative of a New Industrial Space conflates the distinct periods of growth of these two ensembles. Thus, Amin and Robins (1989) concern over what is "new" as against "old" seems partially justified.

A major argument of this final chapter is that the growth of "high technology" agglomeration in Hertfordshire is best depicted in terms of successive layers of "high technology" investment (Massey, 1984). That is, rounds of investment in which the **post-Fordist high technology flexible** industrial ensemble of computer services is merely the most recent (see later). It is possible, through careful definition, to associate historical forms of "high

technology" with particular periods of accumulation and the New Industrial Spaces thesis takes this approach. However, in the empirical application of this approach, the proponents of the New Industrial Spaces have failed to continue systematically this distinction. The connection of "high technology" with periods of history gets lost in the move to the empirical. Yet this failure cannot be ignored for, if rectified, it may well transpire that the **(truly) New** Industrial Spaces (and the spatial logic held within them) are less widespread than we have been led to believe.

The concept of industrial ensembles

In principle, however, the overarching concept of the "(flexible) industrial ensemble" held within the New Industrial Spaces theory is to be welcomed. For, in particular, it breaks what is increasingly seen as a sterile and even misleading typology within industrial studies, namely the manufacturing - services dichotomy. The identification and growth of the "producer services" has highlighted a variety of assumptions emanating from this distinction. Particularly relevant for industrial geographers has been a reversal in the traditional belief that a manufacturing presence represents the pre-condition for the growth of services in any area. It is now being argued that the presence of the producer services is, itself, critical in the successful carrying out of production, to the point of these services presence possibly being a pre-condition for the growth of manufacturing (see, for example, Daniels,1986; Marshall,1982; 1985). But, highlighted by the investigation

of Hertfordshire, is the fact that the concept of the "industrial ensemble" is still very much in its theoretical infancy.

In Chapter Seven a discussion of the context-dependence of the "supplier" and/or "customer" exemplified the issue of how we conceptualise the production process (external to the establishment). Whilst the manufacturing - services dichotomy was seen to encompass an unsatisfactory conceptualisation of the production process, the more advanced view of the "industrial ensemble" (which allows for the "re-integration" of manufacturing and services) does not "solve" the problem.

Indeed, the investigation of Hertfordshire revealed how the transaction costs model still involves an implicit conception of the production process of an ensemble strongly influenced by the manufacturing-services dichotomy. For, in contrast to the model's concentration on critical production linkages with a local supplier base, in Hertfordshire, the "computer services" sector (which corresponded most closely to the archetypal flexible industrial ensemble) revealed a particular form of production process especially geared towards the market (and the need for proximity to it) and not the supplier base. In some cases this was the City of London yet in other cases, such as the firm PB, an important aspect of its product was the after-sales service provided which included a possible two-hour response rate to any product breakdown. This necessarily put a spatial constraint on PB's market area.[97] Furthermore, Gordon's (forthcoming)

work on Silicon Valley has also highlighted that many "critical" production inputs to firms are gained not from "suppliers" but rather the customer.

For the computer services sector of Hertfordshire, critical production linkages often proved to be those with the market and, where the market equated with London, high technology Hertfordshire as supplier base proved of little consequence.[98] In turn, any production linkage dynamic that occurred did so through customer linkages and not supplier linkages, as is implied within the transaction costs mechanism. Thus the possibility that the transaction costs dynamic may be active through "customer" linkages may be raised here (as can the possibility that the rather more traditional label of 'proximity to market' could be used to describe this dynamic[99]) but the New Industrial Spaces thesis provides few clues on this, even though "business services" have been identified as a flexible industrial ensemble.

Moreover, if this is the case, the distinction needs to be writ large, the point being best illustrated by reference

[97] Although it should be added that this constraint had been overcome for one group of "distant" customers through the use of an engineer "on the road" and resident in that area.

[98] A caveat must be added here for in some cases critical "supplies" for firms implied skilled labour and Herts did act to provide these needs. Again, however, this view of "supplies" sets these firms somewhat at odds with the "traditional" manufacturer connected to suppliers of a variety of components and sub-assemblies through which the mechanism is principally mediated.

[99] Martinelli and Schoenberger (1989) have argued this point suggesting that what is new is the type of industry being discussed and not actually the organizational and locational rationale of this industry.

to the Third Italy, held-up as a New Industrial Space of great significance. For, although representative of an agglomeration of a flexible industrial ensemble, the artisan industries of the Third Italy worry little about their proximity to the (international) market. In contrast, for computer (and, more widely, business?) services such proximity may prove to be "critical". The transaction costs mechanism **may** be relevant in both cases but, if it is, its method of operation is also **significantly** different in each case, as is the form of agglomeration outcome. Whilst the New Industrial Spaces thesis may not deny this, neither does it particularly recognise it. Part of the reason why it does not do so lies in the, as yet, underdeveloped concept of the industrial ensemble used within the theory.

The New Industrial Spaces: Localised production networks

The above discussion on the form of production process of high technology sectors arose out of the research's empirical identification of "production linkages" of individual establishments in Hertfordshire. Indeed, this research thesis specifically set out to identify (types of) production linkages held within an industrial agglomeration (cf. Chapter Five). Evidence gathered on the Third Italy also represents the systematic investigation of a series of "local production networks" (see Amin, 1989, for an overview of this research). In the course of gaining this evidence, researchers have raised a variety of issues concerning the conceptualisation and investigation of "local production networks". Yet, while such issues are necessarily present within the New Industrial Spaces

thesis, their very nature as "issues (of contention)" often seems to have been passed over.

What is a local production network?... More than just agglomeration.

An initial point to raise is the pre-eminence of the "Third Italy" as an example of a (New Industrial Space) local production network. What must not be lost sight of is, however, the variety and number of studies of this region which have occurred (including well before the region's labelling as a New Industrial Space). In contrast, in the transference of this model of "local production network" to other regions, too often its emergence from within a **systematic** investigation of **production linkages** has been overlooked. The fact of agglomeration has become enough, the fact of local production linkages assumed. A most extreme, but illuminative, example is that of Scott's (1988b) work on biotechnology in the Ile De France, although most of his work is by no means this cursory.

In a survey of (80) *establishments* of the growing biotechnology industry in the Scientific City (Ile De France region), Scott (1988b) maps two clusters of between 10 and 15 establishments. He concludes that:

> "The biotechnology industry (or at least parts of it) in the Scientific City thus appears to be in the incipient phases of spatial nucleation and differentiation. It is probable that these tendencies are based on increasing interunit linkage... though

only scattered and partial evidence is currently available (see below). It seems reasonable to expect that, if markets continue to grow, further agglomeration will occur on the basis of deepening social divisions of labour in biotechnology production and the expansion of interestablishments linkages." (op.cit.,p.74)

Let us turn to this scattered and partial evidence for inter-unit linkages. Firstly, Scott returns to the greater conception of "high technology" growth in the region, principally electronics (not biotechnology), to argue that:

> "...recent empirical studies have indicated that the establishments forming this pattern are now starting to constitute a *system* of industrial activities, for there is evidence of their increasing interdependence in the form of input-output relations, subcontracting activities, and technical collaboration and exchange." (Scott,1988b,p.74, author's emphasis).

Moreover, a few spin-offs from research establishments have been identified but even so Scott acknowledges that direct contact between researchers and industrialists has still only weakly developed. Thus, he concludes that the Scientific City is an emergent technopole which has not yet quite taken off.

Some further questions may, however, be pertinent before we draw such a conclusion. Firstly, two (very) small clusters of biotechnology establishments in the Scientific City were identified. But how do these fit into the national picture of biotechnology growth in France? How many other clusters of between 10 and 15 establishments are to be found in the

country? Secondly, what are the important linkages in the biotechnology industry? Scott says of the industry:

> "...it is not so much a homogenous sector as it is a disparate assemblage of industrial activities whose sole common denominator is a broad but diffuse connection to biological science."
> (Scott,1988b,p.73)

These activities vary from foodstuffs and brewing to agriculture to medicine to pollution controls, so what are the critical production linkages of the biotechnology industry?

If it is to the customer, evidence of which is to be found within other high technology sectors, how does the Scientific City meet these various needs? Moreover, one particular fact which is known about "customers" is that (in Britain at least) they are increasingly involved in downstream *integration* such that the biotechnology industry is experiencing high rates of acquisition and take-over (Oakey et al.,1990). This highlights that we do not even know if the biotechnology industry of the Scientific City is independent or not. As has already been raised in Chapters Four and Seven, such an issue may be critical in an establishment's choice of (where to hold) a production linkage.

On the other hand, the critical production linkages may be to suppliers but, as to what form these supplies may take..? The evidence we are given relates to the electronics industry of the Scientific City so does the

biotechnology industry behave in similar fashion? The intimation is that external research sources (at least in the Scientific City) may not be critical for electronics, but what of biotechnology?

In fact, biotechnology is an industry (which in Britain is not recognised within official industrial statistics) whose production process, and place in industrial society, is still being discovered and far from understood. Without such understanding identification of its critical production linkages is fraught with difficulty. To then ascribe locational importance to such linkages compounds the problem.

Moreover, it does so in the Scientific City when the only evidence of increasing local production linkages is between establishments **already located** in the region. The case studies from this research have revealed that a variety of processes may lead to the creation of such linkages and, in turn, the conclusion that such linkages, in some cases, are not particularly critical in production, let alone location. The point is that other interpretations of the "partial" evidence of Scott may take place. The argument here is not to seek to prioritise these interpretations over Scott's, merely to point out that **the evidence provided does not allow any interpretation to be prioritised.** In contrast, whilst arguments continue over the significance of the Third Italy, its status as a series of local production networks is generally not in dispute. Much greater investigation of agglomerations must be undertaken before they may be labelled "local production

complexes", let alone New Industrial Spaces.

In his recent work on the technopoles of Southern California, Scott (with Mattingly,1989 and Drayse, forthcoming) has identified individual linkages between establishments. Whilst he has gone on to assert their importance in location, an important additional step has been taken in providing empirical evidence of a production network, as against merely an agglomeration of establishments. The search for, and identification of, individual production linkages does, however, precisely involve a central "issue" raised by the early work on the Third Italy and at the heart of many debates around the existence, nature and significance of "local production networks". That is, how many and what type of linkages go to make up a local production network? The answer is that there is no clear answer! Indeed, the theory of the New Industrial Spaces seemingly (see below) allows for this in arguing that the exact form of any production network, representative of any particular space, is subject to the realms of "contingency".

What is a (local) production network?

Chapter Seven detailed the series of "twists and turns" which must be taken to deal explicitly with the issue of how one identifies empirically a local production network. Moreover, the chapter's method of dealing with this issue, by differentiating the linkages of agglomerated establishments, provided new insights.

By providing an intricate picture of the various types of production linkage which may be found within an agglomeration, wider repercussions were raised concerning the ease with which a variety of "agglomerations" have been listed as New Industrial Spaces (and thus implicitly local production networks). If one goes as far as investigating the production network as against merely delineating an agglomeration, **distinct forms of agglomeration may be discerned dependent on the type of linkage formed within the network.** For example, the difference between the Third Italy "supplier" agglomeration as against the Hertfordshire computer services "customer" agglomeration has already been raised. Further evidence from Hertfordshire depicted (derived) forms of both high technology and non-high technology "ancillary supplier" agglomeration.

Moreover, it was revealed that the "type" of any linkage (and therefore agglomeration) cannot be understood without understanding the form of social relation which is inherent within any linkage. The missing concept of power within the relations of production is a particularly weak aspect of the transaction costs mechanism of the New Industrial Spaces thesis. Harrison and Storper (1990), in particular, have discussed how our view of the (agglomeration) outcome may be significantly altered by the social relations of production within which is set (they use the term governance structure). In turn, within Hertfordshire, whilst case study KA talked confidently of symbiotic relationships with both large and small firms alike, KD provided a vision of a sub-contracting network with the

multinational clearly at the top.

By dissecting high technology Hertfordshire what actually was discovered was a series of "agglomerations within (but also extending beyond) agglomeration" or rather **"local production networks** within (but also extending beyond) agglomeration". For example, there was the precision instruments industrial district focussed on Barnet; and the electronics subcontractors orientated to Hertfordshire's multinational companies which, in turn, used Hertfordshire as the springboard to the South East, Britain or even Europe. Furthermore, these differing production complexes acted as a further impetus for local industry whether high technology computer services (also orientated to the City of London) or travel agents and stationers. Thus, **a variety of production complexes (networks) constituted the agglomeration of high technology Hertfordshire, some of which were driven by separate logics based on a particular linkage process (in which transaction costs may have been the determining factor).**

This is not, however, a declaration of variety (or complexity) for the sake of it. For this variety raises an important philosophical point concerning the concept of "contingency" held within the New Industrial Spaces thesis. For the theorists of the New Industrial Spaces, the variety of type of production agglomeration is generally ascribed as one more contingency in the final description of the outcome of agglomeration. But "contingency" does not merely mean "particularity of outcome", in the sense that the

local "industrial environment" is facilitated by a state-run association pulling together a variety of similar bodies to facilitate contact and exchange in one instance, or the system of "impannatori" which execute the same function in another (the Third Italy). "Contingency" also means whether or not those conditions are present such that the mechanism may be activated in the first place and also, exactly how the mechanism will operate when activated and with what results (ie. agglomeration or not). It is through this meaning of "contingency" that the variety of production complexes found in the agglomeration of high technology Hertfordshire must be understood. It is also by taking this meaning of contingency that knowledge of the social relations of production encapsulated within linkages was shown as essential, for these relations may be a determining (but contingent) factor in the operation and outcome of the transaction costs mechanism.[100]

Linkages as social relations

There is a further aspect of linkages as social relations of production which must also be raised. For as was discussed in Chapter Three, a complete picture of uneven development can only be gained, not merely through

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[100] For example, take the pattern of the multinational surrounded by its suppliers. Does this represent the multinational drawing a supplier close-by, due to the transaction costs mechanism but activated by the multinational's power over its supplier a la Fordism, or does it represent the multinational, itself (acting as Sabel (1989) would argue), locating within the supplier network to gain from its "co-operative environment" a la post-Fordism. Both interpretations involve a supplier linkage pattern but with the causal mechanism operating in opposite directions.

"mapping" the numbers and types of jobs, but also through analysis of the geographical organisation of the relations of production which underly these distributions. It is only in this way that the "connectedness" of one region to another may be understood, that the good fortune of one region may be seen as precluding that possibility for another.

Within the New Industrial Spaces thesis, the connection of any particular space to the "outside" through production linkages held at a variety of spatial scales, including possibly the global, is acknowledged. Thus, for example, Scott has depicted how Silicon Valley is set within an international division of labour in the semiconductor industry (Scott,1988b; Henderson and Scott,1988). The point is, however, that all these production linkages, from the local to the global, also represent the spatial ordering of the social relations of production. Moreover, their coming together in any particular space necessarily inserts that space into this "global order of things". In turn, this insertion necessarily places constraints upon how that particular space, and other spaces connected to it, may develop. In other words, this interdependency of spaces implies that not all can be winners. Most simplistically, agglomeration cannot occur everywhere, there is a limit to its generalisation.

Following this line of thought, whilst Silicon Valley may represent a New Industrial Space, it also represents a space at the pinnacle of the international division of labour in semiconductors. Silicon Valley's position at the

pinnacle necessarily implies that others cannot be at the pinnacle and implies that it holds "linkages" which cannot be reproduced without Silicon Valley changing (losing?) its own position in the order of things (see also Martinelli and Schoenberger,1989; Amin and Robins,1989). The point is, however, that such implications (and the complete picture of uneven development) can only arise through a recognition of the framework of the social relations of production within which the New Industrial Spaces are set. That framework is formed by production linkages but can only be "seen" if these linkages are also recognised as encompassing social (as well as "quantitative") relations of production.

What is (a) local (production network)?

One other "contingent" aspect to the local production networks of the New Industrial Spaces often unremarked upon is a real, and unresolved, tension throughout industrial geography emphasised by the turn to the "locality" as an object of study in the last decade. Namely, at what point is the spatial boundary of "local" drawn? Within the New Industrial Spaces, the actual spatial scale of "local" ranges from that of the Italian village or town such as Carpi to the M4 Corridor, Orange County or even Southern California. Moreover, the drawing of this boundary is critical for the theory, for production linkages, by dint of them being classified as "local", are ascribed particular properties inclusive of causal influence. And here, ultimately, is where the investigation of high technology Hertfordshire revealed one of the weakest

aspects of the empirical evidence for the New Industrial Spaces.

For, firstly, and in following the methodology applied by Scott, "local" was defined on the basis of drawing a boundary around a concentrated pattern of establishments engaged in the production of "high technology" products. Thus the logic can run, if allowed, that a spatial concentration of high technology industry implies a flexible industrial ensemble which implies the operation of the transaction costs which implies agglomeration. In other words, the tautological use of empirical evidence identified in Chapter Four. While this method of identifying an agglomeration represents a starting point, the tautology must then be broken.

What is critical about the "localities" of the New Industrial Spaces is that they are theorised as **places of process**. In other words, the process of integrated production between firms. Such places are created through the spatially-bounded articulation of this process and thus evidence for this process must be found. Without evidence of this process, any attempt at drawing a "boundary" (or rather defence of the starting-point boundary) must be viewed sceptically. Yet, whilst the "local" borders to a string of New Industrial Spaces have been drawn, the evidence for the processes supposedly creating these borders simply has not materialised.

In the case of Hertfordshire, the search for such evidence was undertaken and eventually led to a totally different

conception of the "local". Or rather it led to a variety of conceptions of the "local". By identifying the spatial extent of those "distance-sensitive" linkages of high technology establishments within Hertfordshire (and thus the spatial articulation of the process of local production), the concept of "local" was defined. And, as already stated, what was actually found was a series of "networks within (but extending beyond) agglomeration" whereby each network articulated its own definition of the "local" but all these articulations held the commmon element of (part of) Hertfordshire as part of that definition. In effect, the process of "localised production" occurred at a variety of spatial scales and to recount, examples of such spatial scales ranged from the industrial district of Barnet; to (high technology) Hertfordshire; to (the City of) London and to the Western Crescent.

Furthermore, what may be drawn from this conclusion is a alternative (and less arbitrary) conceptualisation of agglomeration (place) along the lines presently being developed by Massey (1991) in particular:

> "In this interpretation, what gives a place its specificity is not some long internal history but the fact that it is constructed out of a particular constellation of... [social] relations [of

situation of co-presence, but where a large proportion of those relations... are actually constructed on a far larger scale that what we happen to define for that moment as the place itself, whether that be a street, or a region or even a continent. Instead then, of thinking of places as areas with boundaries around, they can be imagined as articulated moments in networks of social relations and understandings. And this in turn allows a sense of place which is extra-verted, which includes a consciousness of its links with the wider world, which integrates in a positive way the global and the local." (p.9-10)

The implication of this viewpoint is that high technology Hertfordshire may be conceptualised as an articulation of a series of co-existent networks of high technology industrial production (themselves expressions of the social relations of production), each with their own form of attachment to Hertfordshire and each providing Hertfordshire with a particular insertion into the "outside". Finally, however, it remained to be seen whether or not this attachment was coincidental or critical (based on transaction costs).

This viewpoint stands in contrast to that framed by a New Industrial Spaces outlook. For, firstly, these different networks (if known about) are combined under one all-encompassing concept of agglomeration. Secondly, these networks thus act as one, as a localised production entity. Moreover, their connection to this production agglomeration is critical and the emphasis is placed upon the internal connections to, and of, the agglomeration. Thirdly, these connections are deemed critical due to the reduced

transaction costs that they entail.

A fundamental difference between these two conceptualisations of high technology Hertfordshire is the issue of the "co-presence" of production networks. That is, whether or not this co-presence of a variety of networks is simply that or whether their co-presence matters. For if it does matter, it implies that these networks may thus be integrated and may thus be treated as a production network as in the New Industrial Spaces theorisation. Furthermore, by dint of being a single entity, this production network may then primarily be explained by a single process (ie. transaction costs). And it is this locational process which is the final defining criterion of the New Industrial Spaces.

The New Industrial Spaces: Expressions of the post-Fordist "transaction costs" logic of location

If it is argued that the evidence for the New Industrial Spaces fails to meet the third definitional criterion (ie. evidence of the process of local production which delineates such spaces), then the final criterion for identifying the New Industrial Spaces simply has not (and indeed cannot) be met (ie. locational decisions based on this local process of production). The empirical evidence for the New Industrial Spaces thus far has failed to provide conclusive evidence of the locational mechanism behind the pattern. The question as to whether or not the transaction costs mechanism can be (let alone is) the driving force in (post-Fordist) agglomeration has remained.

Following the research carried out in Hertfordshire, clear empirical evidence has now been provided that the transaction costs mechanism is a causal dynamic of agglomeration. Moreover, this research has shown that the mechanism operates at a variety of spatial scales (district, crescent, etc.,) and through a variety of production linkages, both customer (eg.the City) and supplier (eg.the subcontractor). Indeed, the mechanism has also been shown as working within multi-site companies, between branches still identified as such and not "reduced" (or elevated?) to the status of independent single-site firms.

Yet, whilst the evidence from Hertfordshire proves the empirical validity of the transaction costs logic of location, and extends its empirical relevance to include (some) multi-site firms, it also fundamentally argues against the strongest claims made for the mechanism's empirical relevance. There is nothing necessary about the mechanism's operation to create agglomeration and, to put the argument in reverse, (post-Fordist) agglomeration is not necessarily due to the transaction costs mechanism. The mechanism is clearly only one explanation for the pattern of agglomeration. In fact, "production considerations" of the firm, other than production linkages, may equally explain the firm's location within an agglomeration or, moreover, work to override the mechanism and thus the tendency of agglomeration.

Whilst Hertfordshire represents an undoubted contemporary example of high technology industrial agglomeration the

causal processes underlying its growth are clearly varied. The transaction costs mechanism is one such process in the growth of this agglomeration. However, it is only one of several which have coalesced to produce the outcome of agglomeration. To prioritise this mechanism over others would be incorrect and, likewise, to prioritise it as the locational logic of a new era of post-Fordism is, at best, premature (see Amin and Robins,1989; Lovering,1990).

In conclusion, as early as Chapter Four a criticism of Amin and Robins' (1989) against the New Industrial Spaces thesis, and its foundation upon the asserted shift to post-Fordist flexible production, was noted. They have argued that it represents a:

> "...highly selective and singular interpretation of structural change" (Amin and Robins,1989,p.28)

This research thesis has focussed on the New Industrial Spaces as the alleged geographical outcomes of this structural economic change. Ultimately, this research's combination of theoretical critique and empirical investigation of high technology Hertfordshire has similarly revealed that the theory of the New Industrial Spaces represents a "selective and singular interpretation" of the industrial agglomerations of today.

To reach this conclusion is not, however, to say that because the New Industrial Spaces thesis fails fully to explain high technology Hertfordshire it therefore fails fully to explain contemporary industrial agglomeration.

Such a generalisation may not be made from a single case-study. But the investigation has raised issues about the theory of the New Industrial Spaces which are applicable wherever (and whenever) the theory is used to explain such agglomeration. For example, its conceptualisation of the firm and any subsequent behaviour by the firm, and exactly what is meant when using the term New Industrial Space. And, moreover, critical issues as to the methodology of application of the New Industrial Spaces theory and, more widely, exactly how we identify and discuss local production networks.

9.4 High Technology Hertfordshire: An Alternative Reading of a Contemporary Industrial Agglomeration.

Hertfordshire is undeniably a locus for high technology industry. It represents one of the United Kingdom's pre-eminent spatial clusters of high technology producers. What this research thesis has investigated, put at its most extreme, is whether or not this spatial contiguity is purely coincidental. It has done so, however, with the knowledge of a hypothesis which strongly argues that the growth of regions of agglomeration such as high technology Hertfordshire is no coincidence. Rather, the New Industrial Spaces thesis argues that such growth is the direct result of locational imperatives brought forward by the historical shift to flexible production. The foremost of these imperatives is argued to be the increased transaction costs associated with the move to more disintegrated forms of production. Furthermore, additional imperatives are said to

be specialist local labour markets and production environments uniquely suited to the particular type of production engaged in. The argument continues that these various mechanisms somehow combine in the same time and space to drive the growth of agglomeration.

Fragmented evidence for patterns of high technology industrial environment and high technology local labour markets was gleaned from the investigation of high technology Hertfordshire, as was evidence for the operation of the transaction costs mechanism. However, such evidence was far removed from providing proof of a combined and strongly articulated dynamic driving the growth of a "bound" agglomeration. Yet, in hindsight, the reason for this becomes clear. For, within the New Industrial Spaces thesis, regions such as high technology Hertfordshire **are treated as a total**, as a single complete entity whose boundary is defined and common to several linked growth processes but principally transaction costs. The reality of high technology Hertfordshire, however, is an "aggregate agglomeration", a group of distinct production networks with their own boundaries but which overlap in Hertfordshire. With this discovery, however, comes the realisation that such a group of patterns allows for the possibility of a group of processes of their creation and, moreover, a group of processes each with their own spatial articulation.

High technology Hertfordshire constituts a variety of overlapping (local) production complexes whose connection to the county ranges fron coincidental to critical. It is a

constellation of particular networks of social relations. Firstly, this implies that this conceptualisation of high technology Hertfordshire is not static:

> "If places can be conceptualised in terms of the social interactions which they tie together, then it is also the case that these interactions themselves are not static. They are processes...[Therefore] places are processes too."
> (Massey,1991,op.cit.p.10)

Secondly, it is this particularity of constellation which makes high technology Hertfordshire unique. It is what gives Hertfordshire its uniqueness as an agglomeration. Thirdly, this uniqueness comes not only from the present constellation of these relations but also from the historical articulation of such constellations. The high technology Hertfordshire of today is built upon a history of (layers of) constellations of high technology Hertfordshire as a locus of production networks. There are both vertical and horizontal dimensions to high technology Hertfordshire.

<u>The vertical dimension</u>

It is vertical in the sense that it is historical. Some of those production complexes which constitute the high technology Hertfordshire of today have a long history. Indeed, this "history of high technology" has already been discussed as particularly incongruous with the thesis of the New Industrial Spaces. On the one hand, we have the flexible high technology industrial ensemble of optical

precision instruments, present in Hertfordshire throughout this century, or the flexible (?) production ensemble of aerospace consolidated in the post-war period. In other words, flexible high-technology which is not post-Fordist. On the other hand, there are a series of other post-war high technology establishments such as GEC, Bull, DEC, Lucas whose growth has been associated with that of the Fordist era of production. In other words, high technology which may not be flexible. In the transition to post-Fordism these companies (and industries) may be argued to be making the turn to flexible production but that does not allow them to be regarded as part of a post-Fordist dynamic of agglomeration *per se*. Their location in Hertfordshire has already taken place. However, what may be added is that, in the turn to flexible production, such industries may create a further impetus to agglomeration in Hertfordshire, in line with that predicted by the New Industrial Spaces thesis.

This is an important point to make for what it highlights is how previous rounds of "high technology" investment have acted to provide suitable conditions for further rounds of investment in Hertfordshire. It is part of the uniqueness (and advantage) of high technology Hertfordshire. Furthermore, it highlights how the co-presence of networks may, in turn, lead to new emergent powers. The co-presence of aerospace and electronics has led to the growth of an avionics sector. The co-presence of computer services and aerospace is engendering new advances in information systems. In contrast, the co-presence of computer services and optical precision instruments is of little account.

Just one example is how, unlike engineering more generally, the introduction of CNC machinery has not yet taken place as the manufacture of precision instruments continues as a "craft" industry.[101] Thus, the vertical (historical) dimension of high technology Hertfordshire is clearly an important component of this contemporary production agglomeration.

Indeed, it is very important if we are to explain this agglomeration's growth. For this history makes clear that it is **interaction** which has produced high technology Hertfordshire. This implies, therefore, that any search for a single process of explanation for its growth must fail. Rather, the recognition of a variety (and combination) of explanatory processes leads to a different research question concerned with what (historical) weight may be attributed to each process in turn.

The horizontal dimension

The constellation known as high technology Hertfordshire is horizontal in the sense that **in the present period of accumulation** a series of high technology production networks of varied spatial scale overlap in Hertfordshire. These networks range from the small firm industrial

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[101] This move from the co-presence of networks to their integration may be argued as a move closer to the model of New Industrial Spaces' agglomeration. The important difference is, however, that such integration is assumed within the New Industrial Spaces thesis from the outset and thus allows for a monocausal explanation of such agglomeration. In contrast, the approach put forward here allows for different growth processes of separate co-present production networks which may then subsequently move to a shared growth dynamic as they integrate.

district of optical precision instruments to another configuration of the industrial district inclusive of the multinational; from the internal network of multi-site companies to the servicing of a variety of markets whether the MOD, the City or local industry. Moreover, each of these networks is inserted in a particular form into the wider system of production such that high technology Hertfordshire cannot be comprehended without reference to that "outside", whether this is represented by, for example, global joint ventures or the Silicon Valley headquarters of a Hertfordshire branch.

Furthermore, if contemporary high technology Hertfordshire represents the co-existence of a variety of local production networks, just as a history of network co-presence may be seen to have precipitated further rounds of growth, so the contemporary co-presence of these production networks raises the issue of whether or not emergent powers will also, in turn, be produced. In other words, the possibility exists for their combination in at least some instances and thus, possibly, Hertfordshire's movement towards that integrated model of agglomeration represented by the New Industrial Spaces.

One particular "glue of agglomeration" increasingly raised by the New Industrial Spaces theorists is that of "local labour markets" (although other commentators using different perspectives have long argued this to be the case [see, for example, Massey,1984; Morgan and Sayer,1988; Keeble,1987; 1988; 1989]). Evidence of patterns of high

technology local labour markets in optical precision instruments and computer services was found in Hertfordshire. However, as to whether such markets were acting as a causal mechanism of growth would require a further study as would the possibility that they might in some way integrate to create a local labour market critical to the whole variety of high technology production complexes located in the county.

An alternative scenario arising from co-presence may also be raised and with it an important point. For, while the history of high technology agglomeration in Hertfordshire is a history of interactions, it is also a history of positive interactions - a spiral of growth. Yet, as this final chapter is written, high technology Hertfordshire is facing a "crisis". Cutbacks in defence spending and fierce competition and over capacity in computer electronics combined with economic recession has seen a series of major redundancy programmes and restructurings, with Hertfordshire companies hitting the headlines including British Aerospace, ICL, GEC-Marconi, Bull, Hawker Siddeley and Rolls-Royce. The presence of such companies may no longer be so positive. Or may it?

For example, many of the companies surveyed in this research were spin-offs from the likes of British Aerospace and it is argued by some commentators that "recession-push" is an identifiable factor behind the creation of new firms (see, for example, Keeble and Wever,1986). It is also argued by the unions, amongst others, that many of those individuals being laid off hold particular skills which are

in demand and should not be lost. Thus, large firm redundancy could translate into a further impetus to the present growth of new high technology firms in Hertfordshire. Furthermore, other interviewees argued that labour shortages may lead to their leaving the county. Such labour shortages were put down to the pulling power of major local employers such as BAe and their recruitment policies were often viewed as dictating the possible movement out of the county of smaller firms (see also Rainnie et al., 1989). Whether these companies themselves survive the present economic downturn is an open question but, if they do, they will do so in a more favourable climate for labour recruitment. A climate which may see their continued presence in the county.

To conclude, the high technology agglomeration of Hertfordshire is a leading economic region in the present period of structural change. One may call this change post-Fordism if one wishes but, the geographical characterisation of post-Fordism represented by the New Industrial Spaces holds insufficient tools to adequately describe and explain the growth of high technology Hertfordshire.

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